THE CLIMATE OF LONDON

BY

LUKE HOWARD.

INTERNATIONAL ASSOCIATION FOR URBAN CLIMATE

THIS IS THE PRINTING OF THIS EDITION OF THE CLIMATE OF LONDON.

Plate 1
The yearly cycle of Temperature

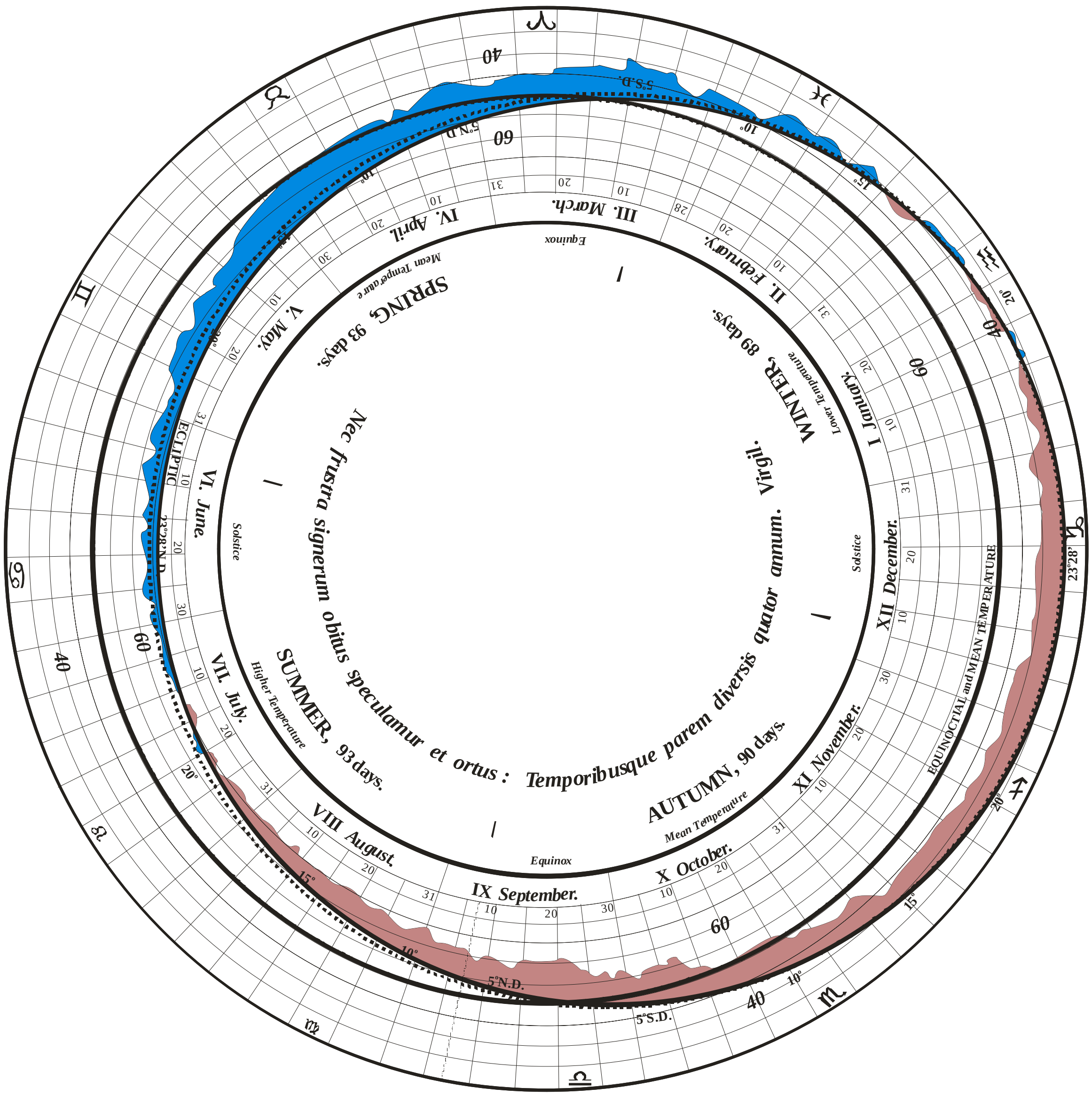
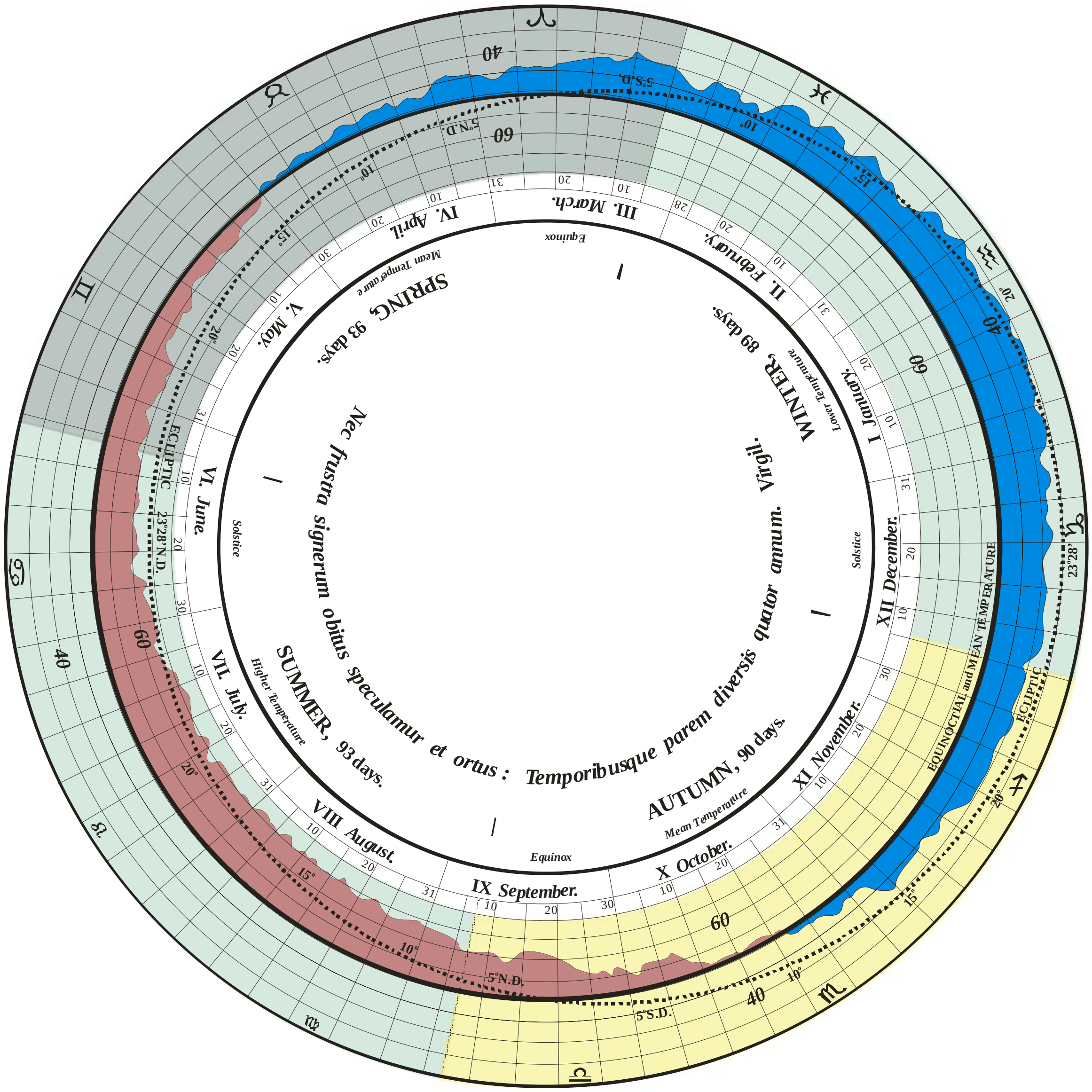


Plate 2
The yearly cycle of Temperature



FOREWORD TO IAUC EDITION.

This edition of Luke Howard's CLIMATE OF LONDON has been produced by the International Association for Urban Climate (IAUC). While Howard is best known for his work on clouds[1], he was also the first to recognise the effect that urban areas have on local climate. Much of his studies on climate, including his description, analysis and observations, are contained in CLIMATE, which can reasonably claim to be the first textbook on climatology. Despite its title, the majority of the book is concerned with weather and climate in general, rather than that of the London metropolis. Nevertheless, one hundred and thirty-two years after its publication, Chandler dedicated his study of the spatial and temporal character of metropolis' climate to Luke Howard (1772-1864), whom he described as the **pioneer of urban climatic studies.**

The 1st edition of CLIMATE was published in two volumes, the first of which appeared in 1818. The second, much expanded, edition was published in 1833 and comprised three volumes. (The latter edition is the basis of this publication.) The first volume is particularly significant as it contains Howard's descriptions and analysis of meteorological elements (e.g. temperature, pressure, etc.) that make up climate. However, this work is only possible because of the wealth of data he collected over a twenty-five year period, 1806 to 1830. These daily data are compiled in tabular form in the second and third volumes and are supplemented by his notes and other information gathered from a variety of sources. Altogether, CLIMATE remains a very impressive work.

Luke Howard trained as a manufacturing chemist and established his own pharmacy in the heart of the London metropolis in 1794, a time of burgeoning scientific inquiry and debate[2]. Much of this activity was concentrated within the professional classes, many of whom were self-educated and were Dissenters (Howard himself was a devout Quaker)[3]. He had a lifelong interest in observing and studying climate and atmospheric phenomena, which he advocates to others as a worthwhile pursuit:

> Now, in no one department of Natural knowledge is the field less trodden, or the opportunity for a successful exertion of the judgment in establishing general principles greater, than in Meteorology, in its present state. There is no subject on which the learned and the unlearned are more ready to converse, and to hazard an opinion, than on the Weather — and none on which they are more frequently mistaken! This, alone, may serve to show that we are in want of more **data**, of a greater store of facts, on which to found a Theory that might guide us to more certain conclusions; and facts will certainly multiply together with observers…. So, to become qualified to reason on the variations of our own Climate, we should begin by making ourselves familiar with their extent and progress, as marked by the common instruments, and the common natural indications: for which purpose such a model as the present Volume may be found very serviceable. (p.xvi)

The Introduction has two parts (associated with the publication of the two volumes of the 1st edition in 1818 and 1820, respectively) and is substantially unchanged in the 1833 edition. Here, Howard discusses the instruments and methods that he employs to gather data. One is constantly struck, throughout the entire work, by Howard's concern for methodical and accurate recording. For example, on many occasions he compares his measurements with those made by the Royal Society in the heart of the city. In his analysis of Rain, he finds that the values recorded at the Royal Society are deficient and are of little scientific value:

> The average Annual rain of the ten years (from 1820 to 1830, omitting 1826) is 17.615 in. which corrected for the elevation of the gauge gives 23.277 — **a quantity falling below the real average of the district by more than two inches**. It may be said that probably other causes than such as have been stated, and those peculiar to a great city, contribute to this deficiency. It would be very satisfactory to be able to appreciate the action of such causes, and their annual share of effect — but until an Instrument, which is understood to be that of so respectable a Scientific corporation, and the indications of which they have so long been in the habit of publishing, shall be deemed worthy of **daily use** when Rain is falling, we shall in vain expect from this quarter the **data** needful even for the construction of the problem. (p.83)

Scientific advancement in any field requires that information and data can be shared. Among the obstructions to progress is the absence of an agreed terminology. It is in this area that Howard is best remembered. In the Introduction to the second edition, his 'Essay on Clouds', which classifies clouds into seven discernible types and provides a universal lexicon based on Latin, is reprinted. Howard's scientific mindset is illustrated by his justification for his cloud terminology:

> But the principal objection to English, or any other local terms, remains to be stated. They take away from the Nomenclature its present advantage of constituting, as far as it goes, an universal Language, by means of which the intelligent of every country may convey to each other their ideas, without the necessity of translation. And the more this facility of communication can be increased, by our adopting: by consent uniform Modes, Terms, and Measures for our observations, the sooner we shall arrive at a knowledge of the phenomena of the atmosphere in all parts of the globe, and carry the science to some degree of perfection. (p.xv)

The impact of London upon its climate is discovered by Howard when he compares his temperature records against those made by the Royal Society at Somerset House. He concludes that 'the temperature of the city is not to be considered as that of the climate; it partakes too much of an artificial warmth, induced by its structure, by a crowded population, and the consumption of great quantities of fuel in fires' (p.2). His is the first analysis of two related, but distinct issues:

1) the urban 'contamination' of meteorological records and,
2) the magnitude and cause of the urban effect.

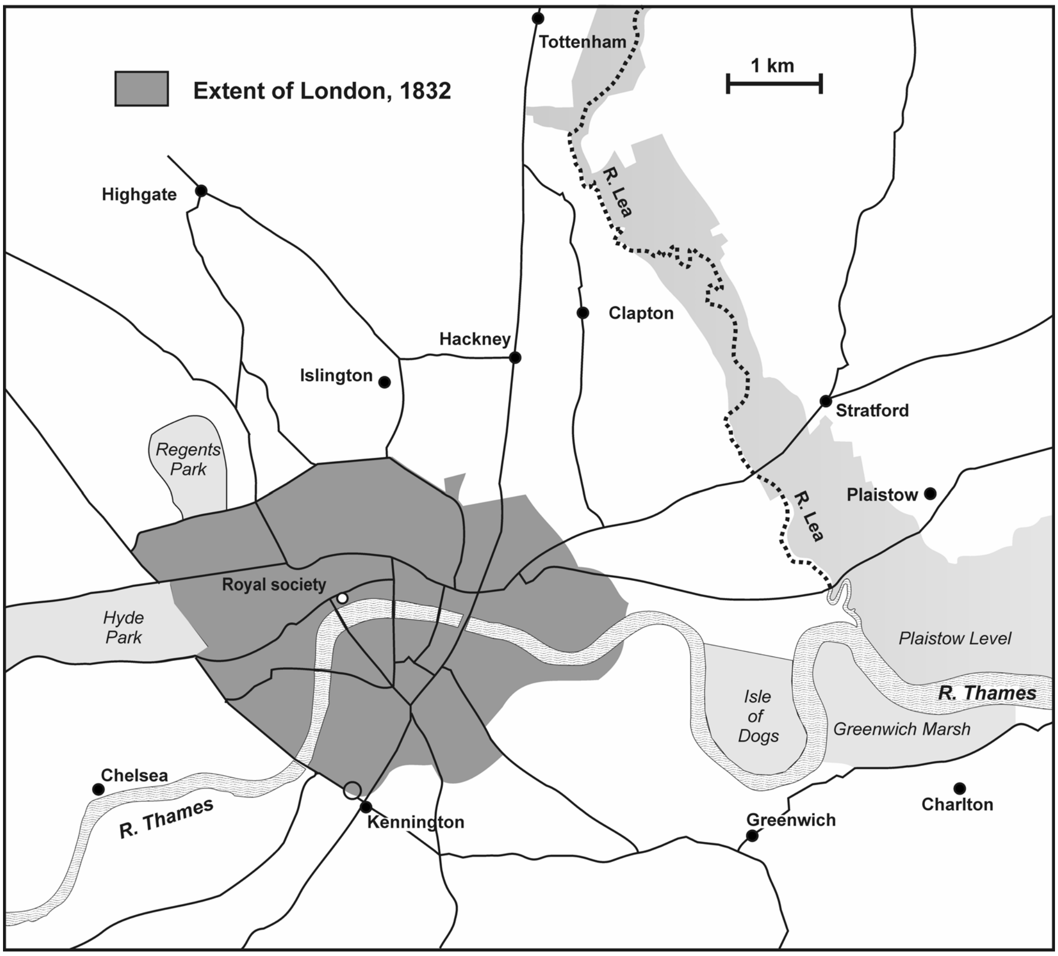
Howard's analysis is based upon temperature records gathered at three different sites outside London (Table 1, Figure 1) and one site (Royal Society) within London. The urban effect is examined as the temperature difference between his 'urban' and 'rural' sites (ΔT_{u-r}). 'Unfortunately, his exposures varied and were far from standard — at Plaistow, 1809 a village 6.4 km east of London, the thermometer hung beneath a laurel bush, and at Tottenham, where readings were taken between 1813 and 1816, the thermometer was 3 m above the ground on the north wall of a house'[4]. The exposure of the Royal Society's instrument is not clear.

Table 1.
Luke Howard's Observations 1806-1830

Years	Location	Originally Published†
1806-09	Plaistow	Athenæum
1810-11	Stratford & Clapton	Unpublished
1811-12	Plaistow	Nicholson's Philosophical Journal
1813-19	Tottenham	Thomson's Annals of Philosophy
1819-1827	Tottenham & Stratford	Annals of Philosophy, Philosophical Magazine and Journal
1828-30	Stratford	Unpublished

†Howard's original tables were published as a Meteorological Register in a number of journals.

Figure 1: Map of London area in 1820.[5]

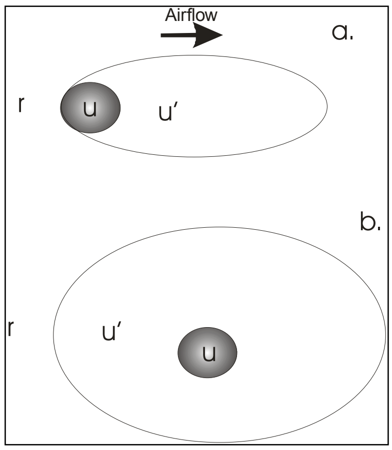


It is climate, as observed from the vantage point of London, rather than the distinctive urban climate of the metropolis that is of particular interest to Howard. Consequently, part of his analysis is concerned with removing the urban influence:

> Thus, under the varying circumstances of different Sites, different Instruments, and different Positions of the latter, we find London always warmer than the country, the average excess of its temperature being 1.579°. But as the same causes which produce an artificial elevation of temperature in London, must likewise influence, in a smaller degree, the country, the Mean of which for the ten years ending with 1816 is 48.79°, and as the second fractional figure was uniformly neglected in taking the Monthly means for the Annual average in the Register of the Royal Society, I shall for the present abate a little of the one, and add to the other; and for the purposes of comparison rate the **Mean of the Latitude and level** of London at 48.5°, and that of the **Metropolis itself** at 50.5°. Future observations with Thermometers previously compared, and a greater degree of care to secure the fractions, may determine these with an accuracy not as yet attained. (p.3)

The means by which Howard 'discovered' the urban effect have become commonplace. In an ideal study, the urban effect, measured as ΔT_{u-r}, would be assessed from a continuous set of observations that begin prior to urban settlement. Over a stable climatic period, the unique contribution of the urban area could be identified and extracted. However, most studies are based on comparisons between observations made at existing 'urban' and 'rural' sites. Consequently, the selection of these sites is critically important.

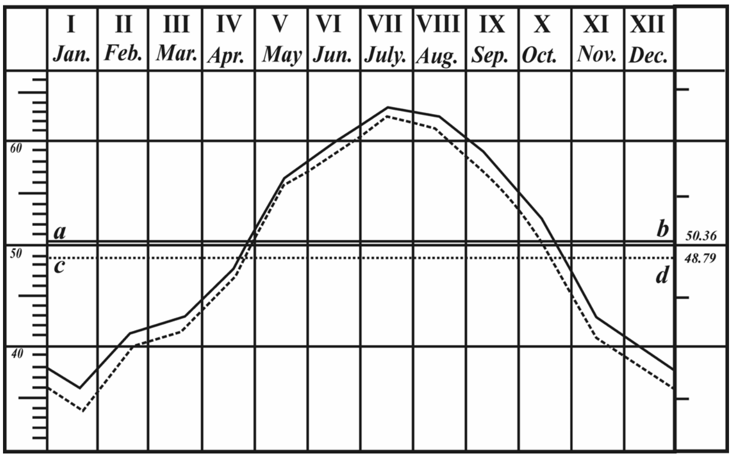
However, Howard is hardly to be criticised for making use of the available records, which were few in number and short in duration. In fact, as the quotes above illustrate, he was aware of degrees of urban influence. It was not until the 1970's that Lowry[6] formulated the problems inherent in examining the 'urban effect'. He identifies three separate components in any set of measurements: the 'background' climate, the effects of the local climate and the effects of local urbanization. For example, London has a background climate associated with its position in the mid-latitudes and on the western side of Europe. It has a local climate as it is situated within the Thames basin and, of course, it has its urban influence. Consider the figure opposite. The urban area (u) has an effect on its environs (u'). Outside this area may be considered rural (r), where just the background and local effects are present and the urban effect is absent. The problem with establishing the urban effect (ΔT_{u-r}), is that the shape and extent of the area u' will vary with weather and climate. In the upper diagram (a.) airflow from one direction carries the urban effect in one direction downwind forming a narrow elliptical area. A site within this zone of influence now has a degree of urban influence. In the lower diagram (b.) a lengthy sequence of weather events (a climate, in fact) has established a zone of influence around the urban area. Lowry concludes that, in the absence of pre-urban observations, the urban effect may be only estimated.



In the Summary to CLIMATE, Howard provides a concise statement of the temporal variation of ΔT_{u-r} and hints at its spatial character:

> The **Mean Temperature of the Climate** … is strictly about 48.50° Fahr.: but in the denser parts of the metropolis, the heat is raised, by the effect of the population and fires, to 50.50°; and it must be proportionately affected in the suburban parts. The excess of the Temperature of the city varies through the year, being least in spring, and greatest in winter; and it belongs, in strictness, to the **nights**; which average three degrees and seven-tenths warmer than in the country; while the heat of the day, …. falls, on a mean of years, about a third of a degree short of that in the open plain. (p.147)

Figure 2.[7]



Many of the temporal characteristics of the urban effect on air temperature observed by Howard are now confirmed. For example, Chandler's examination of the air temperature difference between central London and the surrounding country areas demonstrated the superiority of the urban temperature throughout the year.

Figure 3.[8]

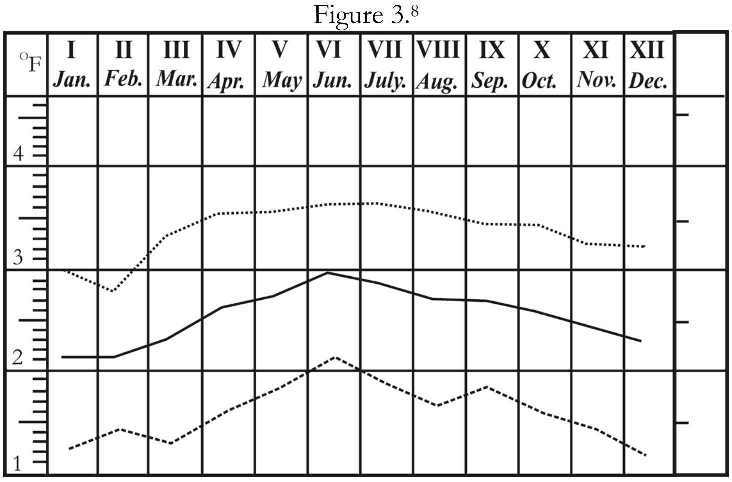
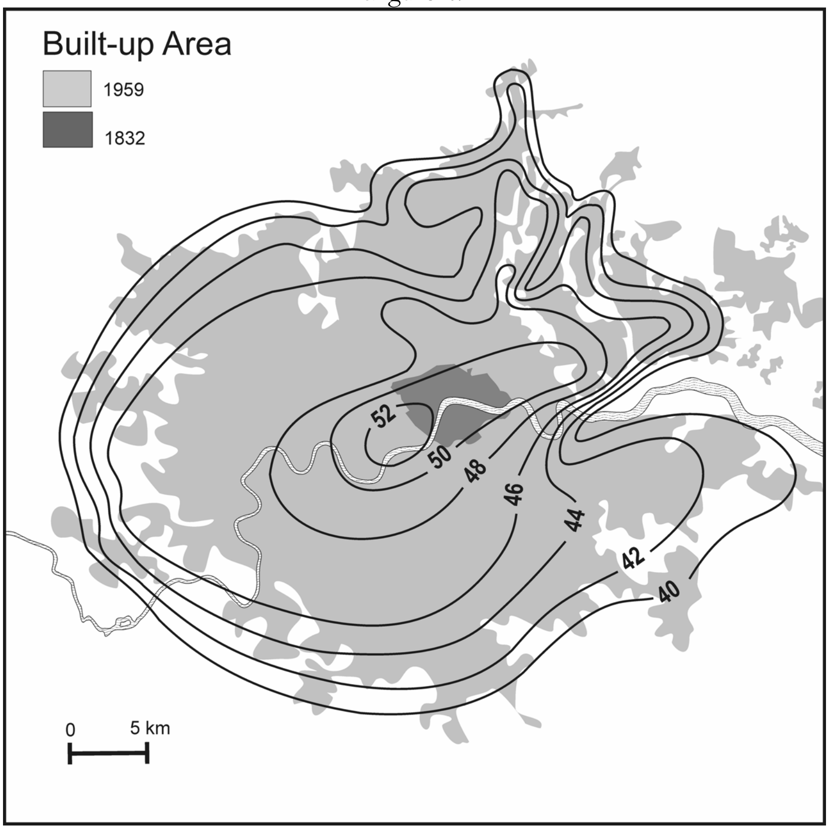


Figure 3 shows average differences in the minimum, mean and maximum air temperatures (shown as a dotted, solid and dashed line, respectively) between London and the surrounding countryside (based on the period 1931 to 1960). It reveals that the urban effect to be greatest in the minimum temperatures during the Spring and early Summer. However, a direct comparison with Howard's work should be avoided. Apart from the differences in observational practices, the London of 1820 was substantially different to the place examined by Chandler in the twentieth century.[9]

Although Howard never took simultaneous measurements at different sites in London and its environs he correctly deduced that it was an urban phenomenon and that, most likely, its effect lessened in the suburbs. When detailed spatial information became available a century later and was mapped, the urban temperature effect was revealed as a 'pool' of warmer air that occupies the built-up area. Generally, it has been found that the magnitude of this urban heat 'island' increases toward the core of the settlement, where building density is greatest. Where 'natural' features (e.g. parks and rivers) remain they appear as pools of cooler air within this general pattern. These features can be seen in Figure 4, which shows the distribution of the minimum air temperatures (ºF) for 14 May, 1959.[10]

Figure 4.



Defined in modern terms, Howard is describing (as Figure 4 does also) the urban 'canopy layer' effect on air temperature. The canopy layer may be defined as the air that lies below roof level. The outdoor canopy layer acquires its properties through interaction with the adjacent surfaces (building walls and street surface) and through exchanges of air with indoor (across building openings and gaps) and outdoor (between streets and with the overlying atmosphere) spaces.

Howard's examination of the urban effect consists of a description of its character from which he deduces potential causes. His analysis attempts to account for the elevation of London's temperature to varying degrees throughout the year and his explanation invokes causes, some of which are intuitively 'obvious' and others of which are relatively sophisticated.

> That the superior temperature of the bodies of men and animals is capable of elevating, in a small proportion, the Mean heat of a city or populous tract of country in a temperate latitude, is a proposition which will scarcely be disputed. Whoever has passed his hand over the surface of a glass hive, whether in summer or winter, will have perceived, perhaps with surprise, how much the little bodies of the collected multitude of Bees are capable of heating the place that contains them: hence, in warm weather, we see them ventilating the hive with their wings, and occasionally preferring, while unemployed, to lodge, like our citizens, about the entrance.
>
> But the proportion of warmth which is induced in a city by the Population, must be far less considerable than that which emanates from the fires: the greater part of which are kept up for the very purpose of preventing the sensation attending the escape of heat from our bodies. A temperature equal to that of Spring is hence maintained, in the depth of Winter, in the **included** part of the atmosphere, which, as it escapes from the houses, is continually renewed: another and more considerable portion of heated air is continually poured into the common mass from the chimnies; to which, lastly, we have to add the heat diffused in all directions, from founderies, breweries, steam engines, and other manufacturing and culinary fires. The real matter of surprise, when we contemplate so many sources of heat in a city is, that the effect on the Thermometer is not more considerable.
>
> To return to the proportions held by the excess of London, it is greater in winter than in summer, and it sinks gradually to its lowest amount as the temperature advances in the spring, all which is consistent with the supposition, that in winter it is principally due to the heat diffused by the fires.
>
> It appears that London does not wholly lose its superiority of temperature, by the extinction of most of the fires in Spring: on the contrary, it is resumed in a large proportion in the Sixth month, and continues through the warm season. It is probable, therefore, that the Sun in summer actually warms the air of the city more than it does that of the country around. Several causes may be supposed to contribute to this: the country presents for the most part a plain surface, which radiates freely to the sky, — the city, in great part, a collection of vertical surfaces, which reflect on each other the heat they respectively acquire: the country is freely swept by the light winds of summer, — the city, from its construction, greatly impedes their passage, except at a certain height above the buildings: the country has an almost inexhaustible store of moisture to supply its evaporation — that of the city is very speedily exhausted, even after heavy rain. When we consider that radiation to the sky, the contact of fresh breezes, and evaporation, are the three principal impediments to the daily accumulation of heat at the surface, we shall perceive that a city like London ought to be more heated by the summer sun than the country around it. (p.9-10)

This analysis is relatively complex. In summary, he identifies four causes for the observed differences in air temperature:

1. Anthropogenic sources of heat resulting in atmospheric warming, particularly in winter.
2. The geometry of urban surfaces which 'traps' radiation and obstructs 'free radiation to the sky'.
3. The effect of urban 'roughness' in impeding the passage of 'the light winds of summer'.
4. The availability of moisture for evaporation in the country.

While the first cause is invoked to explain the excess warmth of London in the Winter, the latter three are used to explain the fact that 'London does not wholly lose its superiority of temperature, by the extinction of the fires in Spring'.

The causes of the warming effect are explored in greater detail when Howard considers the rates at which the urban area warms and cools relative to the surrounding country.

> But this effect is not produced suddenly. For while, in the forenoon, a proportion of the walls are exposed to the sun, the remainder are in shade, and casting a shadow on the intervening ground. These are receiving, however, in the wider streets, the reflected rays from the walls opposed to them; which they return to the former, when visited in their turn by the sun. Hence in the narrow streets, especially those that run East and West, it is generally cooler than in the larger ones, and in the squares. Hence too, in the morning of a hot day, it is sensibly cooler in London than in the country; and in the evening sensibly warmer. For the hottest time in a city, relatively to the hour of the day, must be that, when the second set of vertical surfaces having become heated by the Western sun, the passenger is placed between two skreens, the one reflecting the heat it is receiving, the other radiating that which it has received. Many of my readers must recollect having felt the heat of a Western wall, in passing under it long after sunset. (p.10)

Howard's analysis is readily translated into modern research on the urban effect, which is framed in terms of its energetic basis. Specifically, the energy budget of the urban canopy layer can be expressed as follows,

$$Q^* + Q_F = Q_H + Q_E + \Delta Q_S$$

Where each term represents a flow of energy: Q^* is net radiation, Q_F is heat added by anthropogenic activities, Q_H and Q_E are sensible and latent heat exchanges, respectively and ΔQ_S represents energy added to, or taken from, the urban fabric. The net radiation term can be decomposed into solar (or shortwave) and terrestrial (or longwave) radiation ($Q^* = K^* + L^*$). In Table 2, the suggested causes of the canopy layer urban heat island (UHI) are presented in terms of their effect on these energy budget terms.

Research has shown that the UHI is strongest at night under calm and clear skies. Under these conditions, those terms requiring turbulence (Q_H and Q_E) are at a minimum and there is no solar radiation available. Moreover, with few exceptions, Q_F is generally small in magnitude. In these circumstances, the energy budget is greatly simplified,

$$L^* = \Delta Q_S.$$

This implies that, when the urban temperature effect is greatest, it is primarily a product of cooling driven by loss of longwave radiation to the sky which is offset by the withdrawal of heat from storage. In urban areas, the canopy surfaces (building walls and street surfaces) have a limited 'view' of the sky and consequently longwave cooling (L^*) at night is reduced. In addition, the materials of which the urban fabric is composed are impervious and dense. Such materials are characterised by high thermal conductivity and heat capacities, which allows daytime energy gain to be stored for withdrawal during the night. By comparison, rural surfaces (like pastures) have an almost unimpeded view of the sky and the thermal properties of the underlying soil vary greatly with moisture content. Under these ideal UHI conditions, the magnitude of ΔT_{u-r} will depend on the respective sky geometries and thermal properties at both urban and rural sites that will govern the comparative rates of night-time surface cooling.

Table 2.
Suggested causes of modern canopy layer Urban Heat Island.[11]

Energy Budget term	Urban features	Urban effect
Increased absorption of solar radiation (K*).	Canyon geometry	Increased surface area and multiple reflection
Increased long-wave radiation received from the sky (L↓).	Air pollution	Greater absorption and re-emission
Decreased long-wave radiation loss from surfaces of buildings and streets (L↑).	Canyon geometry	Reduced sky view factor
Heat added by human activities (Q_F).	Buildings & traffic	Direct addition of heat
Increased storage of heat in city fabric (ΔQ_S).	Construction materials	Increased thermal admittance
Decreased latent heat exchange (Q_E).	Construction materials	Increased water-proofing
Decreased sensible and latent heat exchange ($Q_H + Q_E$).	Canyon geometry	Reduced wind speed

It is a pity that Howard had no means of recording wind velocity except by direct observation. With detailed wind information he would certainly have examined the correspondence between $\Delta T_{u\text{-}r}$ and wind-speed, to which he alludes. In addition, he had no comparative data to examine rates of evaporation or differences in humidity. His examination of the urban effect was therefore largely limited to temperature (he had little trust in the available urban rainfall data). Howard did not attempt to formalize his analysis by examining the relative magnitudes of the causes he hypothesized (such as the anthropogenic contribution). Moreover, he did not consider the impact of urban construction materials on the thermal properties of the city's surfaces. Despite this, Howard identified virtually all of the factors that are responsible for the UHI – that he did so in 1820, at the very beginning of the scientific study of weather and climate is remarkable. By any measure, 'Luke Howard's account is monumental'.[12]

Notes

1. See, for example, Day J.A. and Ludlam F.H. 1972: Luke Howard and his clouds, *Weather* 27, 448-461 and Pedgley D.E. 2003: Luke Howard and his clouds. *Weather* 58, 51-54.
2. This period is described in Chapter 54, *Knowledge is Power* in Ackroyd P. 2001: **LONDON: The Biography**. Vintage, London.
3. The best account of Howard's scientific development, particularly in relation to clouds is to be found in Hamblyn R. 2001: **The Invention of Clouds**. Farrar, Straus and Giroux, New York.
4. This quote is taken from p.147 of Chandler T.J. 1965: **The Climate of London**. Hutchinson & Co., LTD., London.
5. This map is based on *The Environs of London*, Published by Baldwin and Cradock, 47 Paternoster Row, London. Published by the Superintendence of the Society for the Diffusion of Useful knowledge. February 1st, 1832, Drawn and Engraved by H. Waters. (Source: http://www.londonancestor.com/maps/)
6. This discussion and diagram are based on Lowry W.P. 1977: Empirical estimation of urban effects on climate: A problem analysis. *Journal of Applied Meteorology* 16, 129-135.
7. This is Figure 3 in the text (p.9) and shows the annual temperature curves for the city (solid) and the countryside (dashed). The labeled horizontal lines represent the means for the city (a-b) and countryside (c-d).
8. This figure is based on data in Table 60 of Chandler, 1965.
9. London during the 18th and early 19th Century is described by Schwarz L. 2001: London 1700-1840, p641-671 in **The Cambridge urban history of Britain** edited by D.M. Palliser, P. Clark and M. Daunton. Cambridge University Press, 2001. He describes London in the early nineteenth century as 'a built-up area, itself a kaleidoscope of neighbourhoods, set amidst a large and amorphous region' (641). The period of Howard's work 1800-1830 was a period of rapid population growth (from about 1 to 1.5 million) resulting from continued in-migration and a fall in the death rate. By the mid-1960's, London had expanded to cover an area of 1942 km^2 and contained a population of about 8.5 million (Chandler, 1965).
10. This map is redrawn from Figure 55 in Chandler, 1965.
11. This table is adapted from Oke T.R. 1982: The energetic basis of the urban heat island. *Quarterly Journal of the Royal Meteorological Society* 108, 1-24.
12. Chandler, 1965: p.147.

ACKNOWLEDGEMENTS.

This edition of THE CLIMATE OF LONDON was created from a scanned version of the 2nd edition, originally published in 1833. Copies of CLIMATE are rare and are not normally available for handling. Fortunately, a copy of this text formed part of a microfiche collection* from which copies were made. These were subsequently scanned and converted into text using optical character recognition (OCR) software†. If the original text is clear then OCR will readily convert a document with few errors however, scanning a copy of a text that was itself a copy inevitably results in many errors that must be manually corrected. The tables (both those at the end of Vol. I and those of daily observations in Vols. II & III) in particular, were prone to errors in the conversion stage. At the time of the 1833 printing Howard listed his errors in a Table of Errata, which I have corrected here - any errors that remain are mine.

It was not possible to duplicate exactly the fonts and layout employed in CLIMATE. However, I have attempted to reproduce the style and intent of the original as far as possible. For example, Climate uses *italics* throughout the text to represent various levels of emphases. In the second and third volumes, all of the cloud names are italicized. In this edition, I have retained the italics for the Clouds however, where it was apparent that Howard wished to emphasize a point I have used **bold** text.

All of the figures in this edition have been redrawn from copies of the originals. To the extent it was practical, the style of lettering and the use of solid and dashed lines to distinguish among curves was followed. In some instances, this edition of CLIMATE reproduces drawings (e.g. see Figure showing the Cymose form of the Cirrostratus on p.79 in Vol. II) that were originally printed by woodcut. Every attempt was made to duplicate the gray tones and line-work employed in the original. The 2nd edition of CLIMATE used colour on four occasions. The colours have been retained here in Plates 1 & 2, which are the most complex diagrams in the work. In Plate 6 of Vol. I (p.116), where Howard used colour for the area under the curve marked ***n-m***, we have substituted light and dark gray for red and blue, respectively. In Vol. III (p.291), Fig. 4 shows a partial rainbow that, in the 1833 printing, is has several colour bands corresponding to those colours produced by a prism. Here, this figure is produced in grey tones.

Several people deserve credit for their work on this edition. Prof. Marilyn Raphael and Sigrid Rian of the University of California at Los Angeles provided a copy of the 2nd edition of CLIMATE. At UCD, Dublin, Stephanie Halpin helped in the scanning process and Maeve O'Connell helped in the proofing. I owe special thanks to Stephen Hannon for his considerable work on the diagrams and to Paul Gallagher of SATTAL for his efforts in ensuring that the work was published in time and to a high standard.

This work was printed by SATTAL (Walkinstown, Dublin) and bound by Antiquarian Bookcrafts (Rathfarnham, Dublin).

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* Goldsmiths'-Kress library of economic literature; no. 28395.
† OmniPage Pro Version 14.0, Scan Soft Inc.

The

CLIMATE OF LONDON

DEDUCED FROM

Meteorological Observations,

MADE IN THE METROPOLIS,
AND AT
VARIOUS PLACES AROUND IT.

BY LUKE HOWARD, GENT.

CITIZEN OF LONDON; HONORARY CITIZEN OF MAGDEBURG; FELLOW OF THE ROYAL SOCIETY, AND HONORARY ASSOCIATE OF THE SOCIETIES OF ARTS OF HAMBURGH AND LEIPSIC.

IN THREE VOLUMES.

A SECOND, MUCH ENLARGED AND IMPROVED EDITION,
IN WHICH THE
OBSERVATIONS ARE CONTINUED TO THE YEAR MDCCCXXX:

ILLUSTRATED BY ENGRAVINGS ON WOOD AND COPPER.

Sic vos non vobis fertis oratra boves!

VOL. I.

Containing an Introduction, with the necessary Descriptions of Instruments, and Definitions of terms used;-A Series of Dissertations on the several parts of the Subject;- A Summary of the Phenomena of the Climate;- General Tables of Results, and a copious Index.

LONDON:
HARVEY AND DARTON, GRACECHURCH-STREET;
J. AND A. ARCH, CORNHILL; LONGMAN AND CO. PATERNOSTER ROW;
HATCHARD AND SON, PICCADILLY; S. HIGHLEY, FLEET-STREET;
R. HUNTER, ST. PAUL'S CHURCH-YARD.

1833.

TO

SIR PETER LAURIE, LORD MAYOR,

THE COURT OF ALDERMEN,
AND COMMON COUNCIL OF THE CITY OF LONDON.

RIGHT HONOURABLE AND GENTLEMEN,

IF your protection may be claimed for any work of labour and ingenuity about to be offered to the Public, (and the present is a time in which authors need protection,) it is surely for a **History of the** CLIMATE OF LONDON — our Civil Commonwealth, my native place, **the Metropolis of the empire.**

Having given to the subject a considerable portion of time, through an occupied and studious life, I had already published, in a limited Edition, some Results of my labours. These I am now about to bequeath to my country, in a larger and improved form: the Observations of twenty years being extended and confirmed by those of fourteen additional seasons.

This is done in the hope that, when our Civil and Religious privileges (of late so much and so beneficially discussed) shall have been settled, and our differences composed, men will find leisure and inclination to attend to things once the agreeable and improving recreation of public characters at their homes — to Science and the Arts of Civilized life.

I had feared that a harsh unsocial feeling, the result of Religious and Civil discord, had come over us; in which all that was **ingenuous**, all that served to soften and refine our manners, was in danger to be lost — a prospect for every friend of his country to shudder at! But some late evidences of an increased attention to these pursuits, and of solicitude to promote them, induce me to hope that I have been mistaken; and that even for the coming generation I shall not have written in vain. That men will yet be found, not so wholly sunk in the vortex of business and strife, as not to pay some regard to that wonderful system of cause and effect in nature, which is ever in play around them.

The work I have now the privilege of presenting, under your patronage, to my Fellow Citizens, is calculated to inform them, on the ground of observation and fair induction, (apart from Mathematical dreams and fine spun theories,) of what they may desire to know of the Climate and Seasons of the district in which they dwell. It will be found enriched, besides, with an abundance of facts drawn from authentic sources, respecting the phenomena of other climes. It may be used, either as a book of reference, or (by those who possess but a moderate share of previous scientific information) as a **Lecture on the Science of Meteorology**, of which it treats.

Such are its claims to the notice of the City of London — a notice you have (by the permission to use this liberty) kindly contributed to secure to it. Six and twenty years ago, upon the day of the entrance of the Chief Magistrate upon his office, the author began to keep his Register of the Weather for **Publication**. He has derived much, in addition to his own, from matter of like kind before in print; and from the labours of faithful associates. Having however pretty long ceased this daily account, he has been content to be occupied, at intervals, in digesting and preparing for public use what he found ready to his hands: satisfied that the Science he is thus promoting rests on the solid basis of a Natural System; that it needs only to be studied in order to be known; and only to be cultivated, to bring forth fruits beneficial to his country and to mankind at large.

I find I must now resume the first person, and conclude with the assurance of my being, under every due feeling of respect and attachment,

Your faithful friend and fellow-citizen,

THE AUTHOR

REFERENCES TO THE PLATES AND DIAGRAMS

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VOL. I.

INTRODUCTION TO THE FIRST EDITION

Printed in 1818

GENERAL OBSERVATIONS

METEOROLOGY, though greatly advanced of late years, especially in what regards the perfection of its instruments, and the art of observing the changes of the Atmosphere, is yet far from having acquired the regular and consistent form of a science. Its facts lie for the most part scattered, or rather buried, in Volumes chiefly taken up with other more cultivated branches of Natural philosophy: and it is only where detached publications have been ventured on, by Individuals engaged in the study of particular classes of phenomena, that its principles have been developed with the clearness and method of which they are susceptible. A pretty large number of observers have been long engaged in doing for this science the office which the Chaldean shepherds are thought to have performed for Astronomy. We may now probably venture, with safety, to anticipate some of those conclusions which posterity will otherwise have to draw from our data — to lay the ground-work of the edifice, if not to proceed to build, with the present materials. Should it be inquired, for what end — the answer (without travelling to more remote consequences) may be, for the benefit of **Agriculture** and **Navigation**: two objects of that magnitude, that the most distant prospect of the smallest permanent addition to our store of knowledge and experience concerning them, will be slighted by none but those who have not duly considered the influence of science on the arts, and of these on the well-being of society.

An extensive co-operation of observers in different countries has been justly deemed essential to the perfection of Meteorological research.* But if we except the single instance of the Society at **Manheim**, patronized by the Elector Palatine, the voluminous Transactions of which, compiled from an extensive correspondence, include the years from 1781 to 1785, there seems to have been nothing done on a great scale to attain this object.

In the mean time observations continue to be made and published throughout Europe; and it is probable that many Individuals have acquired, at least, a knowledge of the peculiar features of their own Climate, and of the facts which, properly arranged, would form its **History**. The production of such a work for each of those districts, in which the requisite observations have been made, would

* Kirwan on the Variations of the Atmosphere, Dublin, 1801.

greatly abridge the labour, if it did not remove the principal difficulty, of a general view of the phenomena of our Atmosphere, in their various: localities and relations through the Year: which being obtained, we might proceed to constitute, on sound principles, the theory of the science.*

The Volume, which on such considerations is now offered to the public, is composed chiefly of the observations of **ten years, from** 1807 **to** 1816 **inclusive**, made in the neighbourhood of London. They have appeared, for the most part, as Monthly Reports in different scientific Journals; but of necessity in an insulated form, and without the connexion and the illustrations which it has now been my endeavour to bestow upon them. They are intended to form (**in a Second Volume**) the basis of such a methodical account as I have hinted at, of the Climate of **London**: or rather of that district in which the Metropolis and its sub-urban branches, have, during the last ten years, been rapidly extending.

OF THE CALENDAR AND ARRANGEMENT.

In introducing to the reader's notice this Collection of observations, I ought in the first place to account for the peculiarities of the arrangement. I had given them, from the first, to the press, not as usual, in Calendar months; but in periods of a Lunar revolution. In so doing I had two objects in view.

In the first place I obtained an earlier insertion in the periodical publications (which come out on the first of each month) than would have been possible, had I carried them up to the close of the preceding month: the difference, as the reader will perceive, is, on an average, two weeks in my favour, though at the expense to the publisher of inserting one Table more in the course of two years. Secondly, and what more induced me, my attention had been for some years called to the question, so much agitated among Meteorologists, whether, and in what way, the relative positions of the Moon in the different parts of her complex orbit, influence the state of our atmosphere. I thought the most convenient way of investigating this subject, and which might bring out, even unexpectedly, facts capable of deciding the question, would be to digest my Results in Lunar periods at once. I lost by this means the facility of having them compared monthly with those of other Observers: and I obtained, in return, materials sufficient for deciding in the affirmative the first part of the question above mentioned, as well as for throwing, possibly, some light on the second; which, however, is one of too great difficulty to be treated with much success, except by **combined** and **extensive** observations.

Having adopted, at the commencement, a period beginning at the **new moon**, the first three years will be found thus arranged. From the close of the year 1809, however, I preferred the **Last quarter**; as by setting out from this, the Phases of New and Full moon appear in the midst of their respective moieties of the observations.

One other circumstance I may here notice. I have prefixed to the Calendar names of the months their numerical designations, and where I write myself, I use these in preference. This is the phraseology of the Society of Friends to which I belong, and is from principle, as well as education, a part of my form of Christianity. The Reader, who may not approve of this peculiarity, will therefore be pleased to tolerate it; which he will do the more willingly, on finding that it interferes but little with his convenience in reference.

The following is the method I use in noting my observations. About **nine** in the morning, I make the round of the Instruments (the **situation** of each of these will be noticed, in treating of it in its place); I find it the securest way to do this with the slate and pencil in hand. The direction of the

* In the spring of last year, [1817] I attempted to give a coup d'œil of the facts and principles of this interesting department of knowledge, in the way of Lectures to a circle of friends. The best sketch which I was able to get ready for the occasion, aided by the globe, some graphic representations, and a few experiments with instruments, proved so far satisfactory, that I have been induced to give expectations of enlarging and publishing it. But I cannot promise, as my friend William Phillips (whose "Lectures on Astronomy" instructed and gratified the same audience) has ventured to do for me, that this shall be done "at no distant period."

Wind, for the past twenty-four hours, usually from memory but with due reference to the present posture of the Vane, is noted for the **first** column.

The actual place of the quicksilver in the **barometer**, with the place it has moved from, as indicated by the hand index, are put down for the second and third columns; and in the fourth and fifth the situation of the two indexes of the **thermometer**, which are then adjusted with the magnet. The amount of **rain** is ascertained and noted for the seventh column. The actual place of the index of De Luc's **hygrometer** occupies the sixth column — **but always a day in advance** of the other observations: all of which, **as relating to the past twenty-four hours**, come under the date of the day **preceding** that on which they are thus noted. In other words, the day I use extends from nine in the morning to nine the next morning. The **daily Evaporation** occupied the sixth column before I began to make use of the Hygrometer. After inserting these in their places in a book, previously ruled, and the ruled page dated throughout, I add, on the opposite page, miscellaneous Notes, from memory, as to past, and from observation as to present phenomena.

OF THE WIND AND VANE

In noting the Winds, I have used only eight points of the compass; the observations are therefore, in general, but approximations to truth. I have endeavoured to give the **prevailing wind** for the day; neglecting this consideration only to show the order of succession, or on account of a remarkable degree of force.

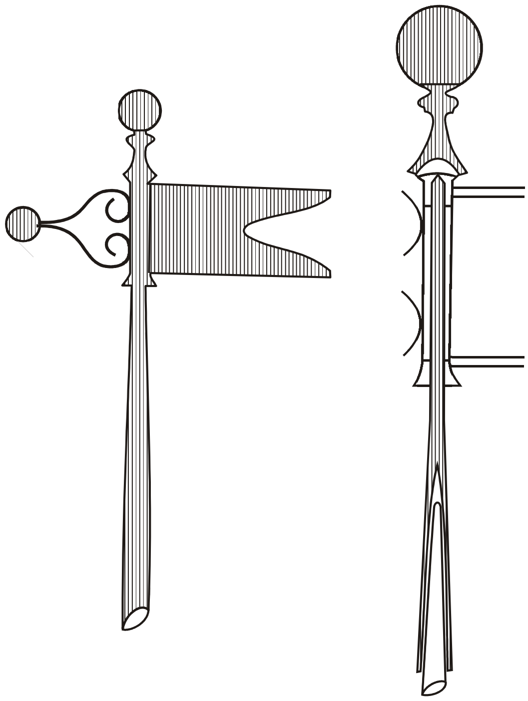
If we reflect on the height of even the denser part of the Atmosphere, and the great proportion of night to day in our winter months, when the winds are busiest, we shall be forced to admit that our knowledge of the currents in the variable climate of these Islands is very imperfect. Like fishes inhabiting the bottom of an ocean, we are insensible to much of what passes over our heads.

The **Vane**, however, is not the limit of our means. We know that certain winds always set in above, before they are felt below; and it is when they come so low, as that we can detect their direction (in the day-time at least) that they have the greatest influence on the character of the season. These subsiding currents may often be traced by bringing some elevated streak or spot of Cloud, which may appear at first motionless, into visual conjunction for a short time with a fixed object, such as a tree-top, or the parapet of a house. Balloons are more effectual, as they show every current they pass through; but they are too troublesome for frequent use. The low currents, which glide up and down the valleys in a calm evening, are often amusingly marked out by the **Smoke**; which they will carry to a small distance, and then return at an acute angle in the opposite direction. And this means of detecting light winds is at no time to be neglected.

For the strength or violence of the wind, I have employed only the terms in general acceptation. An arbitrary **Estimate** of the force by marks or numbers, I consider as conveying nothing more definite than the usual phrases; and I have never possessed an Instrument for measuring the degree of force that satisfied me in use. Nor would the daily use of an instrument, if constructed on more certain principles, be convenient; except in prosecuting specially an inquiry into this subject. Perhaps some ingenious artist may one day overcome the difficulty for us, by making an Anemometer, which shall register its own indications for the twenty-four hours. There is a good design for one, to show the wind and its force **at the time of inspection**, by Kirwan, which may be seen in the Philosophical Magazine, vol. xxxiv. p.247. It is extracted from the Transactions of the Royal Irish Academy for 1808, and exhibits a good basis for the above-mentioned project.

I have always employed a very moveable and sufficiently elevated Vane. As this instrument is often clumsily made and fixed, I shall take this opportunity to lay down some principles, by attending to which, a workman may be enabled to set up a good one.

1. As to **Form**: it should be simple, to ensure durability; and such as that the **resisting surface** may be as nearly as possible confined **to one side of the spindle**. It is curious to observe how this principle is commonly violated on our public Edifices. Either some inelegant caprice takes possession of the architect or artificer, or it is taken for granted that a new Vane must be unlike any old one in existence. The shortest way to convince the work-man on this point will be, to propose to him to



solve the probable effect [as to resistance] of making a vane **alike on both sides**: as he will soon see that such a vane would be continually taken on its broadside by the wind; and consequently, that every approach towards this equality of resistance must both diminish steadiness, and increase the strain on the spindle.

2. As to **Suspension**: a spindle of hard iron, tapering to a point not finer than that of a crayon, should enter into a Tube stopped by a harder substance. A **flint**, having a smooth concave face on one side, will answer for this, and it may be fixed in a socket as much larger than the tube itself as is necessary, and so joined to the tube. The Spindle is likewise to pass through guides inserted in the tube, and to be sufficiently long, to allow for subsidence by wear at top. On it, the moving part should rest in equilibrium. The Counterpoise is best made by a loaded ball, carried out to the proper distance (which may be found by trial before fixing it) on a slender, single or double branch of iron. The whole is to be kept down on the spindle by means of a second, and larger, moderately loaded Ball, mounted on the centre of the vane, and turning with it.

There are vanes to be had ready-made in London, which fulfil pretty nearly these conditions, that of great durability excepted. This is best insured, where expense is not an object, by using copper well gilt for the material.

3. As to **position**: it is obvious that this instrument ought to be clear of deflections and eddies, from objects on the same or a higher level.* That it may the more easily be so placed, the spindle may end in a taper shaft, capable of receiving a fir pole: the latter should be well painted before fixing, and the Vane put on and adjusted after it is fixed.

In this stage of the business the workman will require a Compass, if **letters** are as usual attached to the vane; and he must observe, that when the Needle, by moving the compass round, is made to point to the **Variation** north (at present 24° West of North), the north on the card of the compass will be the point for the north of the vane. The exact Variation is now annually inserted in the Philosophical Transactions, and other publications.

* The site of Geneva remarkably exemplifies the effect of local position in this respect. Here, owing to the direction of the valley, the vanes point almost constantly either to SW or NE: the cross winds going over above their level.

The vane in the figure is on the scale of an inch to a foot: the Section, in which the spindle, the flint, and the guides are represented, is drawn two inches to the foot: the spindle and tube are stout enough for a much larger vane: the branches carrying the ball are seen edgewise.

OF THE BAROMETER

On the construction and uses of this instrument much has been written which need not be here repeated. In applying it to the purpose of the Meteorologist, it is the due attention of the observer to the **changes** it undergoes, rather than the perfection of the instrument itself, that serves to promote science. Yet as the mean of a given number of observations at any place is applicable to other not unimportant ends; and as these means must for the most part differ by but small quantities, it is desirable that every Barometer, from which we are about to take the pains to register a series of changes, should have the previous labour bestowed upon it of adjustment to a fixed standard: which is probably done in but few instances at present. As to corrections for the slight variations of Temperature which take place in an inhabited apartment, I have not thought it needful to enter upon them. These niceties appear to belong to a more advanced state of the science; and there are other sources of discordance, at present more obvious, in the generally varying and imperfect construction of the instrument.

I have employed the same Barometer in all my observations at home: but in consequence of slight accidents, it has been more than once re-filled, in doing which I have endeavoured to restore, as nearly as possible, the former adjustment. It is on the wheel or siphon construction, made by **Haas** about the year 1796. The scale extends through a space of eighteen inches, and the workmanship is delicate; the weight which rests on the quicksilver preponderating by but a few grains, so that the **Radius**, or hand, makes a sensible vibration on suddenly opening or shutting the door of the room, as well as during the passage of the strong gusts in a storm of wind. I find an advantage in having it fixed in a place by which, when at home, I pass frequently in the course of the day: for as often as I perceive, by the divergence of the radius from an **index**, which is also made to traverse the circle, that there has been a movement, I adjust the latter to the place, and thus secure the Extremes. At the hour of observation, if the movement has been wholly in ascent or descent, the Extremes are found, the one in the highest or lowest point of yesterday, the other in the present place of the radius: but if there has been a change of **direction** to any extent worth notice, the index (which is never put back again in this case, but left in its place) points out one of the Extremes to be noted, and the radius the other. It is rare that such changes happen in the night, or more than once in the twenty-four hours. To obtain a true **Mean** for this period, it would be needful to put down a considerable number of observations. In re-printing my Tables, I have given the extremes only; purposing hereafter to make use, in another way, of the **Medium** heights, which were printed for several years in a third column: and the same, as to the medium heights of the thermometer.

I have possessed for some years an eight-day Astronomical clock, having a Barometer connected with it, made in 1766, by **Alexander Cumming**, and which, on the decease of that excellent mechanic, his family allowed me to purchase by a valuation. This curious instrument records, by means of a pencil supported on the quicksilver, and traversing a revolving scale, the movements of the Barometer throughout the year; requiring for this purpose little more attention than the regular winding up of the Clock. When I bought it, there was a latent defect in the bearings of the escapement, which for a long time gave me considerable trouble, the false beat which it occasioned coming on at uncertain intervals, during which the going was incorrect. This I have at length discovered and remedied; and as I can now put full confidence in the reports of this **Automaton**, I shall probably give them to the public at intervals, with remarks. [This has been done as to a small portion only: the whole, to 1830 inclusive, are contained in this Edition.] In the mean time I may observe, that the advantage it confers on a diligent observer, with respect to the **Extremes** of movement, is less than might have been expected. These may be got nearly as well, with daily attention, in the way I have mentioned, from a good Barometer alone: but in the case of absence from home, in that of great depressions, which may have their crisis in the night, and for studying the succession and character of the different movements, it is a most valuable assistant.

In the autumn of 1801, being desirous of exhibiting on a very large scale the variable pressure of the atmosphere, I determined on filling a Barometer with **Linseed oil**, which is known to remain fluid in the greatest cold that obtains in our winters. The Tube was an inverted siphon of lead pipe, fixed against an outer wall of my house; the short leg of the Siphon, in which the movement was obtained, passing into the basement story. I had the two extremities made of tinned copper, each an inch in diameter. The proportions of the instrument were deduced from a comparison of the respective specific gravities of the oil and of quicksilver. I calculated the range of the Column at about three feet six inches; one half of which being lost by the siphon construction, the remainder might still have been extended by a float and pully, with a proper radius, to a Scale of several yards. I managed by means of the air-pump, and by repeatedly exposing it to the Torricellian void in the tube itself, to clear the oil of the great quantity of **air** which it contained; and in effect to place it in counterpoise with the atmosphere. On proceeding to observe the movements, by means of a rod supported on the shorter column, I found the **range** such as I had expected: but the discrepancy of the proportionate variation of the oil and quicksilver Barometers was continual and great. The cause of this appeared to lie in the changes of Temperature out of doors. These might have been allowed for by calculation: but as it was evident that the lead pipe also must undergo considerable changes of **capacity** from this cause, the project became too complicated, and I gave it up. I still think that in some situations, such as the shaft of a mine, where the requisite height could be obtained for the column, with an equable temperature, such an instrument might be usefully employed, either with Linseed oil, or Water, to procure a large extent of variation.

OF THE THERMOMETER.

I shall say nothing in this place about the common Thermometer, in the use of which the Meteorologist only partakes with others. The Thermometer of **Six** may be called his exclusive property, and it is the best adapted to his purpose. This most useful instrument was invented about the year 1780, by James Six, of Canterbury:[*] the following year was probably the first in which the Temperatures of both day and night were accurately noted; and this observer first discovered that the nocturnal cold is greatest near the surface of the Earth. The idea of a Thermometer to mark the extremes of temperature, appears to have originated with one of the **Bernouillis**: it was worthy of a great genius, and the science will continue to owe much both to the invention which conceived, and to the ingenuity which executed it.

Like some other instruments, however, this has become degraded in the hands of successive workmen: it has now several defects; and as we have no substitute for it of nearly equal merit, I shall bestow some notice on these faults, and point out the most obvious remedies.

1. The **size** of the whole instrument has been injudiciously lessened. Originally, the Tube containing the alcohol was "about sixteen-inches long, and five-sixteenths of an inch in diameter." I now meet with them commonly of about half this length: though it is obvious, that the crowding together of the divisions of the Scale, which ensues from this change, must increase the chances of error, both in graduating and observing: while in point of sensibility (the usual reason for a small bulb) the instrument, can have gained but little.

2. The original construction of the **Indexes**, or floats, has been abandoned, I know not on what account; but the substitute is, at all events, a bad one. A spring made of no better Material than a stiff hair is now imperfectly attached to a needle, which is capped at each end with a drop of glass. But the needle was at first inclosed in a fine tube of glass: this was inserted at each end in a short **cylinder** of glass, nearly of the diameter of the tube in which it was to move; and the spring consisted of a glass

[*] See Philosophical Transactions, vols. lxxii. lxxiv. lxxviii.

thread, drawn out taper from the upper cylinder, to the length of three-fourths of an inch; which, being set a little oblique, pressed lightly on the side of the tube when introduced.

Then as to the **magnet**, [instead of the small ones commonly sold with the instrument,] I would advise such as one as will at all times command the needle: one which will lift some pounds, and with provision for keeping a weight appended to it, to preserve its power. The sinking of the index, which defeats the whole purpose of the invention, I conceive will thus be effectually prevented. At any rate, stiffer Springs and a larger Magnet must be resorted to, to regain its reputation.

3. There is yet a third defect. At the first approach of cold weather, a small bubble of **air** sometimes makes its appearance in the spirit, which, increasing and getting into the tube, at length occupies several degrees of the scale; but without disturbing the results in proportion. [This is the consequence of using spirit which has been some time exposed to the air. I have advised the **boiling** of the alcohol just before using it; for which a Florence flask, over a spirit lamp, will serve very well. It should be only half filled, and of course not corked.] I have got rid of this air, by first cooling the instrument, so as to bring the air back into the spirit tube, and then making the bubble move to and fro in the spirit before the fire: the pressure caused by the expansion of the included air and vapour, soon drives it back into the spirit; but it is apt to re-appear. The **radical cure** is, to break the point of the upper bulb, and let in the atmospheric air: very little waste of the spirit will ensue in a long time, if the point be fine: if it be too solid, the glass may be detached from the frame, and the point cautiously drawn out before breaking, by heating it at the flame of a spirit lamp, and applying another piece of glass when it is hot enough to adhere. But as this requires a practised hand, the workman should leave the upper bulb with a point fine enough to be easily nipped off, should it be found needful. Spirit may be introduced into this upper bulb at any time, by first warming, and the cooling it with the aperture immersed.

4. The descending Scale is often, and indeed generally, graduated further than the lower end of the index is capable of following it. The workman may avoid this, by sparing a few degrees at the ascending extremity of the scale. Here he need not, **for our climate**, ever go **up** beyond 110° [so the index follow] — while, at the cold extreme, the index should be capable of showing 10° below **Zero**, which will suffice in all cases.

5. A Six's Thermometer should be **mounted** (at about five feet from the ground,) and screwed on a fixed support; not hung up free, (as the present construction indicates,) and liable to swing and strike with violent gusts of wind. Or a mahogany frame may be provided with two projecting brackets, into which the box scale may enter by a pivot at each end. By this means the Thermometer may be set facing that part of the general North exposure, where, from the disposition of the surrounding objects, the heat may have the freest **radiation to the open sky**; a point which late discoveries show to be important: and in situations where it is inconvenient to go in front, the scale will then admit of being turned on occasion towards the observer.

To the above mounting, it will in some situations be proper into add a small shelter **above** the instrument, which shall suffice to keep off direct showers at least — and, at a suitable distance on the West side, a shade moveable on hinges to be interposed, in the heat of summer, between the instrument and the rays of the afternoon sun.

As the **position** of the Thermometers which I have used varied in the different stations, it will be most convenient to describe this when treating of the Mean temperature at each.

OF THE HYGROMETER.

In determining to substitute for the daily amount of Evaporation, in one of my columns, the degrees of moisture indicated by the Hygrometer, I had no hesitation in making choice of that of **De Luc**. This instrument is capable of bearing, with little injury, a constant exposure to the air abroad: I have accordingly kept it hung up, near the Thermometer, in a small tin frame, the sides and bottom of which are of open work, with a glass in front: so that the whole instrument is visible, and the air freely admitted, while the rain, and the fingers of the curious, are excluded.

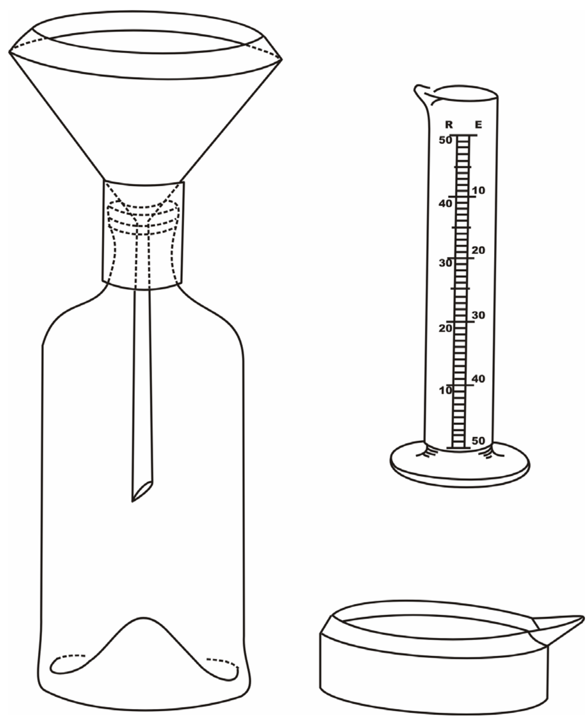
My instrument consists, essentially, of a very slender strip of **Whalebone**, which, having been cut out of the piece **across the grain**, and reduced by scraping to the requisite thinness, with a length of about three inches and a half, is so mounted in a brass frame, with a counteracting spring of wire, as to move an Index round a circular scale of three inches circumference. The shortening of the strip of Whalebone by dryness, and the lengthening by moisture, while the Spring keeps it extended, respectively carry the index towards the Extremes of the scale. The **Moist** extreme, which the inventor fixed at 100º, is now and then attained, in winter, in the natural state of the air: but the **Dry** at no season.

The latter is accordingly fixed by a method, in which the buyer may at any time prove for himself, whether the instrument has had, or retains its proper adjustment. For this purpose, a few ounces of fresh-burned quicklime are to be put into a dry wide-mouthed stopper bottle, with sufficient room above for the Hygrometer to rest upon the lime without soiling the whalebone. The instrument being placed, the stopper is to be put in, and, for greater security, closed round with putty. In forty-eight hours, or thereabouts, it will be seen whether the index, under these circumstances, will pass to **Zero**, which point it ought not to exceed. The Hygrometer is next to be exposed for a few hours, under a close glass to the vapour of water, at a mean Temperature, and if convenient, in a mean state of the Barometer; but without being **immersed** in the water. The index, if right at the other extreme, should now go to 100°.

Should it prove out of its place, yet with the proper range, there is at the bottom of the frame a small screw, by turning which it may be adjusted: but should the range prove several degrees too large, or too small, the instrument should be rejected.

This Hygrometer shows the effect of moisture on Whalebone to be precisely the same as on a deal board: which, as every one knows, will swell, or extend itself in breadth, in a moist atmosphere, and contract again as it dries. Now the board, after a few Summers and Winters, loses this property, or becomes **seasoned**: and there is no doubt that the same effect must be produced in time on the Whalebone. But the texture of the latter substance is so greatly superior in hardness and firmness to deal, that it is probable few single observers will wear out their instruments. If deterioration, however, be dreaded, it may be indefinitely put off, by exposing the Hygrometer only at the time of observation: the few minutes taken up in observing and noting the other instruments, may often, (though they will not always,) suffice to make it take the degree of moisture present in the air. And for such a mode of observing, the delicate **Hair** hygrometer of **Saussure**, of which I have had as yet but little experience, will be preferred by accurate Meteorologists. It is necessary to observe, that though graduated alike, these two instruments do not range together, and their results must not be entered in the same column.

I caused a workman to add to the Hygrometer of De Luc, a pair of detached indexes, to be moved by the one in connexion with the Whalebone; in such a manner as to show the greatest degrees of moisture and dryness, which take place in a given interval: but I have not yet had opportunity to prove how far they will answer in practice. [This instrument was subsequently neglected.]



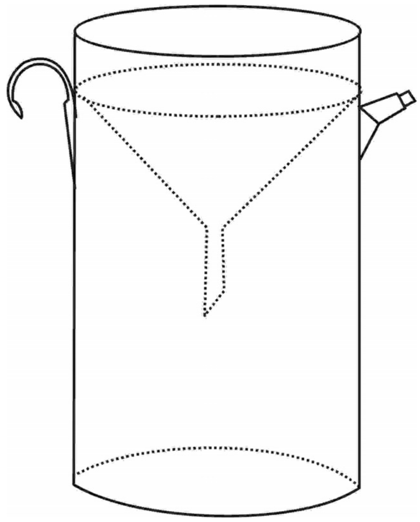
OF THE GAUGES FOR RAIN AND EVAPORATION.

These are treated of together, as being connected in the most essential part, the graduated measure for the water.

The **rain-gauge** consists of three pieces, a funnel, a bottle, and the measure. The **Funnel** is most conveniently made of five inches opening, and of the form represented in the figure: the mouth-piece of brass, turned in a lathe, the remainder of tinned copper. It has two necks: the inner and longer one widening a little downward, enters deep into the Bottle, and conveys the rain: the outer neck is soldered on the cone of the Funnel, having no opening into the latter: it serves the necessary purpose of preventing the entrance of water from the outside; and by resting on the shoulder of the bottle, it gives steadiness to the funnel.

As to the **Bottle**, a common wine-quart will contain from two to two and a half inches of rain on this funnel; but it is better to use a three-pint bottle (technically termed a **Winchester quart**), which has the proportions given in the figure. For an unusual fall of Rain may happen, when a previous quantity has not been measured out: and it on such occasions that we would wish, more especially, to be certain of the amount.

A cylindrical Glass of the depth of eight inches, exclusive of its foot, and an inch and a third in diameter, serves to make the **Measure**. It is graduated in parts, each of which is equal in capacity to the depth of a hundredth part of an inch on the area of the mouth of the funnel. A Glass of the above size will measure out fifty such parts, or half an inch, at once. The graduation is conducted on the principle (which is a medium between calculation and experiment) that a Cylinder of water at a mean Temperature, an inch deep, and five inches in diameter, weighs ten ounces **Troy**. The hundredth part of this, or forty-eight grains, is accordingly taken for the graduating quantity, and the Scale is formed by successive additions, at each of which the surface is marked. Considering the nature of this operation, which scarcely admits of our going to fractions of a grain, I suppose the above standard to be sufficiently correct. I have been accustomed to **etch** the scale on the glass with fluoric acid; but it is more conspicuous when engraved at the glass-cutters wheel. Previously to sending it for this purpose, the whole scale should be traced, either on strip of paper pasted on before it is divided, or in oil paint on the glass itself. A diamond, or steel point, may be used in default of other means, for engraving the scale.

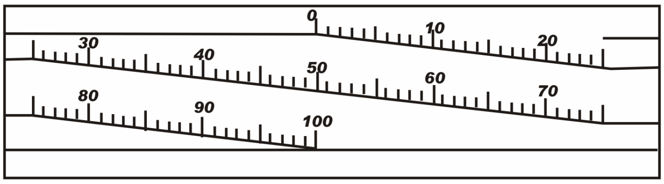


Although I recommend these dimensions as convenient, and have had them executed in different instances for others, I have hitherto used a Gauge, the funnel of which has eight inches aperture, and the Measure is graduated by the quantity of a hundred and twenty-four grains, the bottle being large in proportion.

For Tropical climates, and in cases where a large bottle is found inconvenient, the whole recipient part may be of tinned copper, the **rim** excepted, which is still to be of turned brass. On this construction, a moveable Funnel may be let in, so as to rest below the rim and prevent evaporation; a spout, with a small aperture, mould also be provided at the size, both for the convenience of emptying the water into the measure, and to permit the air, on occasion, to pass out freely. (See the figure above.)

The **Position** which, since the year 1811, I have preferred for the Rain-gauge, is to sink it into the ground, bringing the mouth of the Funnel nearly to the level of the turf; which should be kept cut, so as to leave a clear space of an inch or two around. In winter, when Snow may be expected, it is proper to raise it a few inches. A thick sheet of snow is apt to have a large depression above the Funnel, the surface of which, slightly thawed and frozen again, has, more than once, collected and sent into my gauge a redundancy of water. On the subject of different products from different situations of the gauge, the reader may consult the appendix to Table LXIV.

The graduated measure for the Rain being numbered on the opposite side of the scale downward, serves also to ascertain the **Evaporation**. For this purpose, a cylindrical tinned copper vessel is employed, of five inches diameter within, furnished with a rim to prevent spilling, in which is a lip, set on clear of the cylinder. Two measures, or an inch, of water being poured in, fills two thirds of the Cylinder: the vessel is then placed near the ground, in a situation where it may be sheltered, from rain and have the sun's rays, without reflexion. At the end of twenty-four hours, or a longer period, extending to a week if desirable, but regulated by the season of the year, the water being returned into the measure, the quantity which is evaporated may be read off, and the vessel replenished. For warmer Climates, or longer periods of observation, the depth of the vessel may be increased, and a greater number of measures put in. See Fig. p.ix.

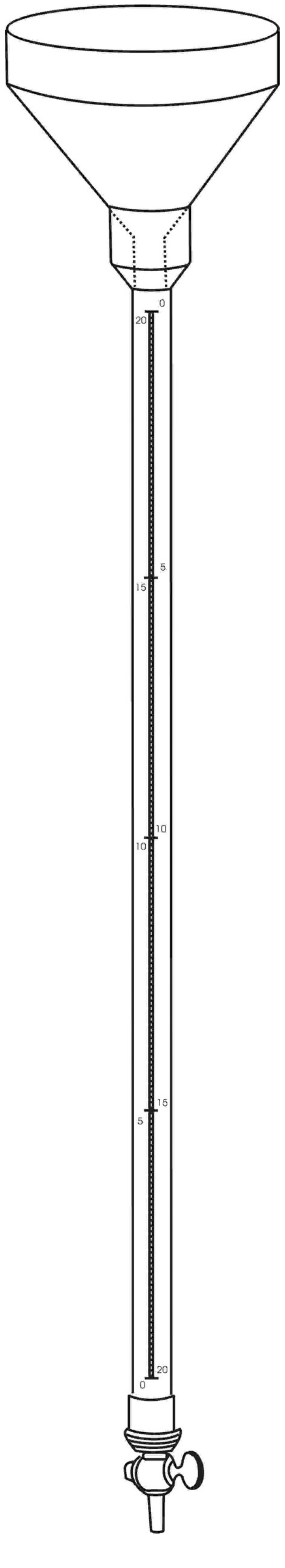


Where the **Evaporation** alone is in question, and the observer wishes to ascertain it daily, without trouble, the following contrivance may be used. On a Plate of glass, six inches long, and an inch and a half wide, a line is to be drawn, near and parallel to one side, to serve for a base. From this a diagonal Scale, etched with fluoric acid, is to be carried up, ascending at the rate of **one** inch in **ten**; so that the tenths of an inch into which it is ultimately divided, shall rise in progression just one hundredth part of an inch above each other. The glass being now fixed perpendicularly on its edge, in a vessel of the proper capacity and depth, (if this be **square** it may be set in diagonally, and supported by the angles,) a little Water is first to be put in; the surface of which is to be brought, by adjusting the position of the vessel, to range with the horizontal line at the bottom of the scale. This adjustment made, more water is to be added, up to the line which cuts the division at **Zero**. Then, in proportion as the surface is lowered by evaporation, it will cut the several divisions in succession, indicating at sight the effect to the hundredth part of an inch.

[I have varied the position of the Scale in this instrument, and made it **an inclined plane**. A piece of plate glass, about eleven inches long, by an inch wide, is graduated in the manner of a measuring rule, in divisions one tenth of an inch apart, which are numbered at every ten, from 0 to 100. The dividing lines being half an inch in length, the water, (when the Scale has been so placed as to make just an inch difference in the perpendicular between the two extremes,) makes a bead, or half round, against the lower surface. This is to be brought to touch the upper division at 0, after which it will descend, forming a tangent to each division as the Evaporation proceeds, and indicating very neatly, by simple inspection, the Results.]

Lastly, for delicate occasional observations on **Rain**, **Dew**, and **Evaporation**, I have an Instrument which will indicate either the thousandth part of an inch, and which I likewise find useful in graduating other gauges. This Instrument, a figure of which is given on the succeeding page, I shall now describe.

A funnel like that of the Rain-gauge, but with an upright cylindrical rim, five inches in diameter, terminates in a glass tube twenty inches long, and of half an inch calibre; having at bottom a good stop-cock. The Tube is graduated on the principle of the glass measure above described: but the divisions are here wide enough to admit of decimal subdivisions. When the Instrument is used for **Evaporation**, the tube is first to be filled to the **Zero at top**; a full bottle of water is then to be added, so that the surface may stand at a proper height in the Cylinder during the experiment; at the close of which, the same quantity of water being returned into the Bottle, the deficiency will appear in the Tube. When for **dew**, or for **rain**, in minute quantities, or at short intervals, water is to be introduced up to the **zero at bottom**, and the inside of the Funnel moistened with a sponge at the outset; the difference in volume caused by change of temperature, must, in these delicate experiments, be obviated or allowed for. This instrument requires, likewise, a support to keep it upright and steady in use.


0
20
5
15
10
10
15
5
20
0

OF THE VAPOUR-POINT.

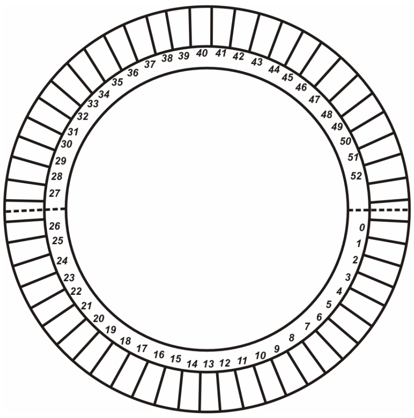
As I have two or three times in the course of my observations made mention of the **Vapour point**, I may here explain, that by this term is meant the degree of Fahrenheit's thermometer, at which a body colder than the air (such as a glass of pump water) will cease to collect moisture from it. For this experiment, (which was first introduced [here] by Dalton, and is a useful one in studying the subject of **rain**, though seldom performed,) the liquid in the glass should be cold enough, either naturally, or by artificial refrigeration, to ensure the effect above mentioned; then, as the Temperature of the glass slowly increases by the contact of the moist air, it is to be repeatedly dried with a clean cloth, till Dew no longer reappears on its surface; at which moment a delicate Thermometer, previously immersed in the liquid within, gives the Vapour-point, or the lowest temperature at which vapour can subsist in the actual state of the atmosphere. See the notes to Table I. LXVII. LXXXIII. [The Reader should also consult on this subject, **Daniell's** "Meteorological Essays and Observations," where he will find a new hygrometer, founded on this principle, with an account of many Experiments on the state of vapour in the atmosphere. Published 1823.]

OF THE CYANOMETER

One of these instruments having been put into my hands by Professor Pictet, at Geneva, in the summer of 1816, I brought it home to make trial of its use; but the almost continual recurrence of turbid skies since that period, has nearly defeated my purpose hitherto. I shall, however, describe and figure it for the reader's information. The figure is drawn one fourth of the actual dimensions. I have not attempted to express more than the general outline.

The Cyanometer of Saussure is, in effect, a circle of small pieces of paper tinted with blue, and pasted on a card, which is open in the middle, and folds in two, with the patterns inward. They are numbered from 0 to 52; the last is of the colour of solid Indigo, that is, nearly black; and the colours lighten gradually through the whole Series, till, at 0, nothing remains but the white paper. The colour goes quite to the outer edge; but on the inner, a space is left for the number.

Its use is, to assist the judgment in determining the degree of intensity of the blue colour of the Sky; which varies greatly in different seasons, and still more in different climates, and at different elevations in the atmosphere. For this purpose it is held up in such a direction that, while a full light falls on the Pattern, the sky may be seen at the same time; and the Card is turned till the sameness, or near approximation, of the Tint of some number is decided on; which is then set down for the colour of the sky.



This invention is chiefly useful to the Traveller, who, in ascending mountains, and in changing climates, meets with a range of colour to which a single situation scarcely affords a parallel. About half the range of the Scale may be found, probably, in our own skies. That they do not attain to the intensity of those on the more elevated parts of the Continent, is manifest from the surprise with which our Travellers view for the first time the blue rivers and lakes of those countries. They forget that they are in fact contemplating, in a natural Cyanometer, a phenomenon to which, by gradual approach, the eye had already become accustomed, when turned to the vault of heaven.

Simple as this little Instrument appears, I have great doubt whether our workmen, who may attempt it, can give it any improvement; save, perhaps, by securing the back with morocco leather, and providing a case. The form and size were certainly adopted after mature reflection, and different trials. Those who incline to exercise their ingenuity on this subject, may do it with more promise, by trying different combinations or thicknesses of **blue glass**, to be viewed against a ground of dead white, in the manner above mentioned.

OF THE ELECTRICAL APPARATUS

There are several ways in which the Electricity of the atmosphere may be investigated, as

1. By **small instruments** managed by the hand, with some of which the most minute quantities of it may be detected. Of these I have had very little experience, and shall therefore omit to treat of them.

2. By the **Insulated rod**, or Conductor. In the first three years of my observations, the reader will find pretty frequent notice of the state of the natural Electricity, obtained in this way. My apparatus was constructed on the plan of that described in the Philo. Trans. vol. lxxxii. part ii. by John Read, who, in the years 1790 and 1791, accumulated a valuable mass of facts on this subject, which he has there reported. I made, however, the following variations in the apparatus: the **Conductor** itself was a single taper Rod of iron, which by a screw at the bottom entered firmly into a brass Cap, cemented on a glass Pillar; the latter standing **free** in a socket of wood. By means of a stout glass tube, and other defences of glass and cork, the rod passed up through an angle of my observations, rising seven or eight feet above the roof, which height I found sufficient. I added to the part which communicated with the ground, a stout **arm**, which turning on a joint, could at any time be shut to the cap of the pillar, so as to make the whole a Conductor to the earth: and in this state I commonly left it when out of use. When I removed my residence, I took down this apparatus, and have not erected it at Tottenham. Hence the deficiency of Electrical observations in the latter years of my series.

3. By the **Insulated kite**. This subject is well handled by Cavallo, in the second volume of his Treatise on Electricity. The few experiments I have made with the Kite amply confirm to me his opinion, that the metallic thread is the **Conductor** in this case, and the kite its support only. I have likewise discovered what seems a material improvement. Instead of twisting together the conducting and supporting threads, as heretofore, I leave the Kite with its string precisely in the state in which boys raise it: so that it may be flown in a pretty high wind, and carry out plenty of line of sufficient strength; or in gentle gales, a lighter string. The conducting thread, which may now consist of the fine lace-thread before intertwisted with the common string, is tied to a loop in the latter, two or three yards below the Kite: so that while the Kite is set up by two persons, a third lets out the Lace from an insulated reel: keeping always to leeward, that the **stress** may be wholly on the common string. When this is let out to the desired length, it is likewise insulated, by attaching a loop tied in it to a hook fixed on a glass handle. By this management, the conducting thread hangs as nearly perpendicular as the wind may permit, and is in little danger of breaking.

Those who attempt to use this apparatus should have skill enough to know when the clouds actually portend, a discharge to the earth: at which times alone I believe it to be attended with any danger. It is the most likely method I know of, to obtain satisfactory observations on the Electricity given to the air by the passage of **clouds**. That of rain, hail, or snow, is certainly best collected by the insulated rod.

4. The variable Electricity of the atmosphere has been found to affect considerably the action of **De Luc's electrical column**. As some instances of this kind occur in the observations of my friend Thomas [now Dr.] Forster, inserted in this work, I shall follow his description of the instrument. It is composed of a great number of small circular and very thin plates, of silver, of paper, and of zinc, placed alternately on each other, and pressed closely together, so as to form a Column. One end of the column thus arranged is observed to become permanently electrified **plus**, the other **minus**: a **bell** is connected with each, and a small ball of metal is suspended between the bells. The whole is enclosed in glass and **insulated**. From the tendency of the Electricity to become equalized, while it is continually renewed, the metallic clapper keeps passing to and fro between the bells. And the varieties in the kind of Pulsation produced by this means, with its occasional intervals, or even cessations for a considerable time, constitute the effects to be studied in connexion with the other phenomena of the season.

OF THE NOTES AND MISCELLANEOUS MATTER

The Notes appended to my earlier Tables of observations were published in an incomplete state: the confined interest of the subject at that period, and some uncertainty as to the probable reception of the Terms used to designate the clouds, made me sparing of them for two or three years. On concluding to insert the suppressed Notes in this work, I found that, from the mode of reference by letters, instead of dates, it would be no easy task to incorporate them with the rest. They are therefore left in the less convenient form of **additions**.

The **Nomenclature of clouds**, to which I have just alluded, having now grown into pretty general use among the Meteorologists of our own country, I shall not need to introduce it to the reader as a novelty. [It is attached, in this Second Edition; to the Introductory matter of the work.] The reader will find the system in its original state in Tilloch's Philosophical Magazine, vol xvi. xvii. and (with some changes not affecting the nomenclature) in Rees's Cyclopædia, article **Cloud**; as also in Nicholson's Philosophical Journal, vol. xxx. It has been abridged and reported in several other publications: and, in the supplement now publishing to the Encyclopædia Britannica, with the addition of a set of new terms for the modifications, intended for the use of English readers. I mention these in order to have the opportunity of saying that I do not adopt them. The names for the clouds, which I deduced from the Latin, are but seven in number, and very easy to remember: they were intended as **arbitrary terms** for the **structure** of clouds, and the meaning of each was carefully fixed by a definition: the observer having once made himself master of this, was able to apply the Term with correctness, after a little experience, to the Subject under all its varieties of form, colour, or position. The new names, if meant for another set of arbitrary terms, are superfluous: if intended to convey in themselves an explanation in English, they fail in this, by applying only to some part or circumstance of the definition; the **Whole** of which must be kept in view in order to study the subject with success. To take for an example the first of the Modifications the term **Cirrus** very readily takes an abstract meaning, equally applicable to the rectilinear as to the flexuous forms of the subject. But the name of **Curl-cloud** will not, without some violence done to its **obvious** sense, acquire this more extensive one; and will, therefore, be apt to mislead the learner, rather than forward his progress. Others of these names are as devoid of a meaning obvious to the English learner as are the Latin terms themselves.

But the principal objection to English, or any other local terms, remains to be stated. They take away from the Nomenclature its present advantage of constituting, as far as it goes, an universal Language, by means of which the intelligent of every country may convey to each other their ideas, without the necessity of translation. And the more this facility of communication can be increased, by our adopting: by consent uniform Modes, Terms, and Measures for our observations, the sooner we shall arrive at a knowledge of the phenomena of the atmosphere in all parts of the globe, and carry the science to some degree of perfection. What would Geography have been at this moment, had such descriptions of boundaries as those we meet with in the book of Numbers, or in Joshua, never given place to the universal language of Maps and Globes?

The **Miscellaneous extracts** might have been made more copious than they will be found on the whole, but I avoided taking them from sources where they were already easily accessible to the reader. They are inserted for different purposes: some, to explain the cause of appearances recorded in the Notes, as in the case of distant thunder storms: others as being supposed to have a more remote connexion with my own observations: lastly, not a few to serve as Examples of meteorological and physical phenomena, to which I might have occasion to advert hereafter. The portion which I derived from the Papers was selected from materials obtained in the following manner:- In the daily paper taken for use at our Laboratory, a line is drawn by my desire, in the margin of all such passages as have any relation to the weather, or to physical phenomena. Thus, though absent, I secure them for future notice. In turning over the File at intervals I extract what suits my purpose, annexing the true or **most probable date**, and retrenching what is extraneous or irrelevant in matter or phrase.

If the conductors of our London papers intend (as without doubt they do) that the many notices of the weather and phenomena with which they favour us, should promote Science as well as gratify curiosity, they will not be displeased at my requesting them to give us these **with a precise date**. A provincial Editor naturally reverts to the day of the week on which a thing happened, and the date of **his** Paper settles that of the event. But when the latter comes to be transplanted into a subsequent London paper, sometimes with, sometimes without the corrective addition to the day, of **se'nnight**, or **fortnight**, the uncertainty is often such as to render it useless to the accurate collector. The day of the month being adhered to in equally cases, would obviate the inconvenience.

The **Language** of these accounts is also commonly vague and unphilosophical: a hard gale of wind is too often "a tremendous hurricane," and frost and floods, hail and thunder, are too frequently stated to have been the most severe or destructive "in the memory of the oldest persons living!" Reporters of unusual phenomena should be cautioned to describe, as accurately as they can, in the first place, **what they saw**, and in the true **order of time**: after which, if necessary, they may draw comparisons, and give vent to their feelings. I am, however, indebted to the public papers for several circumstantial Reports, evidently communicated by men of science; with which the reader may find it not unpleasant to relieve his attention, in looking through this Volume for dry facts and coincidences; and from some of which he may possibly be induced to draw the conclusion, that the milder uniformity and tameness of our own Climate, are, at least, equally desirable with the more splendid and various, but destructive, phenomena of other Zones.

Some disadvantage, I am sensible, attends the publication of this first Volume, while the second is as yet not nearly ready to appear. The Reader may possibly be disposed to compare this collection of fact at the first view to the parts of a dissected Map, turned out before him without the accompaniment of a design, by the aid of which he might put them together. But in this I have followed the natural course of the labour imposed on me by the undertaking. To make out of the detached portions of observations which had been separately formed, **a whole**, was the first thing to be done. And this was most easily accomplished by putting them at once to the press, and supplying what was necessary to complete the Series, as the work proceeded. They were thus brought into a fit state to be perused for the purpose of theory and deduction, in which considerable progress is already made. Until the Results can be laid before the public, what is now produced may serve the purpose of reference, and occasional, information on various points of the history of our climate, for the series of years comprehended in the Tables. Persons moderately conversant with Natural philosophy, will know how to make use of them in this way: still more, they who have been accustomed to make similar observations for themselves. There are indeed but few at present who can be said to **study** the subject, compared with the number of amateurs in Chemistry, in Astronomy, in Electricity, &c. Yet it is one with which Gentlemen possessing the requisite information, together with domestic habits, might very agreeably fill up a portion of their daily leisure. There is nothing splendid or amusing to be met with in the outset of such a course: but, I believe, that even in more attractive pursuits, the pleasure of study resolves itself, sooner or later, into the feeling of the gradual acquisition of knowledge, the perception of the relations, agreements, and differences of facts, and their orderly arrangement in the mind. Now, in no one department of Natural knowledge is the field less trodden, or the opportunity for a successful exertion of the judgment in establishing general principles greater, than in Meteorology, in its present state. There is no subject on which the learned and the unlearned are more ready to converse, and to hazard an opinion, than on the Weather — and none on which they are more frequently mistaken! This, alone, may serve to show that we are in want of more **data**, of a greater store of facts, on which to found a Theory that might guide us to more certain conclusions; and facts will certainly multiply together with observers. He who wishes to study Astronomy (the most perfect, perhaps, because the most ancient of the sciences), must begin, I imagine, where the Chaldeans began, though with so much better means before him:- he must remark for himself in the heavens, the actual courses of the Planets, and the most obvious points in the construction of our own System. So, to become qualified to reason on the variations of our own Climate, we should begin by making ourselves familiar with their extent and progress, as marked by the common instruments, and the common natural indications: for which purpose such a model as the present Volume may be found very serviceable. A moderate knowledge of the phenomena, acquired in this way, will naturally excite a desire to become acquainted also with their causes, and, eventually, with the principles of the science. These have been ably investigated in parts by several writers: in our own language, by Franklin, Cavallo, Kirwan, Dalton, Marshall, Wells: in French, by Saussure, De Luc, Cotte, Bertholon: a work by Beccaria is extant in an English translation; and there are many detached extracts of the opinions of foreign authors, as well as Essays of minor bulk, dispersed in the Philosophical Transactions, and other periodical publications. Dr. Thomson has given a good summary of Meteorological facts in the former editions of his System of Chemistry; and Dr. Robertson has done the same in a separate work. But we are not as yet possessed of a general elementary treatise, displaying in a sufficiently familiar manner the present extent of the Science; which from this cause appears more confined and imperfect than it really is. In the early part of this Introduction, I made mention of some Lectures on meteorology, which I had a view of publishing. These are necessarily a more remote object than the completion of the present work. I must, therefore, entreat the patience of my friends in regard to these: for while I have long owed such a work to the Public, the materials have been accumulating, and the labour of selecting, and arranging, in a small compass, what may be deemed fittest for the purpose, is likely to be yet considerable.

PREFACE TO THE SECOND VOLUME

Printed in 1820

THE Map of my subject being at length delineated, the reader has it in his power to survey it; which he may do either in detail, in the several divisions of **Temperature**, &c. which follow, or first as a whole, in the **Summary**, where it is treated in the order of the months and seasons. On turning over the work now that it is about to be completed at press, I am sensible of some imperfections in the arrangement; which might have been made more easy for the reader, and the text less interrupted by Results in figures, had the whole been reserved, till now, unprinted. The few points of Theory which I have introduced here and there, might likewise have been embodied in a preliminary dissertation; the want of which will be scarcely supplied, to some readers, by the Summary above mentioned. My principal apology must lie, in the want of a good Model, for a design so nearly novel in character: to which may be added a strong inducement to print the several parts, as they were digested, for the sake of easy reference. In attempting to reduce to some sort of method the great mass of observations before me, I was not seldom in the case of the traveller in a South American forest, who is obliged, even where others have gone before him, to cut his way at every step through a tangled thicket. If the **Vista** be in any degree thus opened, those who may follow will scarcely grudge the labour of smoothing asperities, filling up chasms, and making plain the road to the Science. With regard to mathematical discussions, with which it would have been an easy task to some to have interspersed the work, I think it right to avow, that a limited education in that branch of Science has left me unqualified to furnish them: and possibly, to men capable of applying them to the test of sound theory, the simple **data** derived from observation may prove as acceptable as a splendid series of ready-made **demonstrations**. One thing the reader may rely on — that much care has been exercised in the plain calculations which were continually required to bring out my Results. It may be proper also to remark, that for the convenience of those who may incline to take up the subject only in parts, the **Index** has been made copious and minute, to a degree which on any other consideration would have been quite superfluous.

The result of my experience is, on the whole, unfavourable to the opinion of a permanent change having taken place of later time, either for the better or the worse, in the Climate of this country. Our recollection of the weather, even at the distance of a few years, being very imperfect, we are apt to suppose that the Seasons are not what they formerly were; while, in fact, they are only going through a series of changes, such as we may have heretofore already witnessed, and forgotten. That the shorter periods of Annual variation in the mean temperature, depth of rain, and other phenomena of the Year, which will be found exhibited in this volume, may be only component parts of a larger

Cycle is, however, very possible. Otherwise considering that the changes consequent on the clearing of woods, culture, and drainage, with some other less obvious effects of an increased Population, have probably by this time contributed their utmost to its improvement, I should venture to suppose, that our Climate is likely to remain for ages what it now is; and further, that in its great or leading features, it differs little from what it was, when the present elevation of these islands above the sea was first established.

Having despatched the few remarks of this kind that were left for a Preface, I may now claim the indulgence of the scientific reader for some thoughts of a more important nature. In the Introduction to my earliest published observations (in 1807) I find the following remarks on the **end** and **object** of such enquiries. "Every correct Register of the weather may be considered as intended for two purposes: first, as a daily record of the phenomena regarded as passing occurrences; secondly, as a continued notation of facts interesting to the Philosopher, and from which he may deduce results, for the purpose of extending our knowledge of the Economy of the seasons. This application of the subject it is desirable to encourage: for it cannot be doubted, that from views less limited we should draw conclusions less partial as to these changes, and instead of that scene of confusion, that domain of chance, which as commonly seen they present, we should discover a chain of causes and effects, demonstrative like the rest of Creation, of the infinite wisdom and goodness of its Author."- *Athenæum*, vol. i. p. 80. I should indeed regret the many hours of leisure which I have since bestowed on this pursuit, could I not persuade myself, that these anticipations are likely to be in some measure fulfilled: that Meteorology will, by future observers, at least, be rescued from empirical mysteriousness, and the reproach of perpetual uncertainty; and will contribute its share to the support of a proposition, so well illustrated by some of the brightest names in Science, that the "Almighty hand, that made the world of matter without form, hath ordered all things in measure, and number, and weight." - *Wisd.* xi. 17, 20. Or, (to use more modern terms,) that the Creator has, even in the course of the Winds and the variations of the Atmosphere, so adapted the means to the end, that amidst perpetual fluctuations, and occasional tremendous perturbations, the balance of the great Machine is preserved, and its parts still move in harmony: each returning season verifying the assurance given to mankind after the deluge, "While the Earth remaineth, seed-time and harvest, and cold and heat, and summer and winter, and day and night shall not cease."- *Gen.* viii. 22.

I have occasionally observed with regret, in the writings of men of science, the continuance of a phraseology which I would gladly see exploded; which is unmeaning in itself, when strictly examined, but tends directly to evade or weaken the force of some important truths upon the mind — a mode of expression by which **Nature**, personified, is made to do every thing, while the Great Author of nature is never mentioned or alluded to. Surely no well informed mind can now imagine, that the chain of causes and effects, which we contemplate in Natural philosophy, could ever arrange and move itself; that the material world, in which we dwell, and over which we ourselves have such dominion, was originally produced without design or impulse — or that it is without beginning, and will never have an end!

The fading leaves of the Tree which I now behold from my window will, in the course of a few weeks, have fallen to the earth, and their elements will have mingled in part with the soil, in part with the atmosphere. It is in the **nature** of vegetable matter thus to decay, when separated from the unknown principle which gave it organization. In a few Months, other leaves, now concealed in the buds, together with other branches, will have unfolded themselves, adding to the total bulk of the root, stem, &c. which now compose the Tree. It is the **nature** of trees thus to increase in bulk, and extend their parts, by assimilating to themselves the elements contained in the earth and air. The tree, with its new set of leaves, will, however, be the same tree, though it will have changed a part of its substance: this, indeed, it has been doing ever since it first sprouted from the Seed. The tree, then, was in the seed before it grew; it is a part of the **System of nature**; and the best account we can give of its origin, in common language is, that it is the **nature** (natura: that which we expect **to be brought forth**) of the Seed thus to germinate in the moist earth, and of the Tree, thus set growing, to increase to perfection; and lastly, to form in itself other seeds, capable under circumstances which will always occur in the course of **Nature** (natura rerum: that which from our knowledge of the earth and seasons, we expect will be the concurrence of events) to continue the Species.

In this account of some familiar natural effects, the word **nature** has been used in its proper acceptation; in the sense which, unless I am greatly misled by its etymology, the inventor of the term intended for it. But were I now to proceed to say that all this takes place, because **Nature** thus works, or because **She** wills it, it would be but to run away from a plain and positive account of the matter, already on record, to a notion which is at best very obscure and indefinite. I might indeed imagine the existence of a power or principle, **distinct from Omnipotence** and superseding the necessity of Creation and Providence, subsisting in matter from all eternity, and manifesting itself in an infinite variety of forms and operations — I say I might choose to imagine this, but I could never demonstrate or render it probable. I should, then, have nothing solid to oppose to the positive authentic History of the matter, which is this, That "in the beginning" (of the system of nature as we now behold it) "God created the heaven and the earth" — that among other provisions for the use and sustenance of the future inhabitants, He caused the earth to bring forth "the tree yielding fruit, whose seed was in itself, after its kind." From which "beginning," by a succession of effects, which we can investigate and comprehend (though the created principle of vegetable life, immediately acting on matter to produce them be hidden from us) the "kind" or species has been continued to this day.

Divine revelation was alone competent to furnish us with just conceptions, on points of knowledge, neither attainable by the observation of nature, nor demonstrable by just inference from its Phenomena: and without this, it is difficult to conceive how the idea of a Spiritual energy, pervading and governing matter, could ever have been formed by man. We have accordingly, in the book of Genesis, an account of the origin of Nature, which, while it stoops to the simplicity of the human mind, in its ignorance of Physical science, is yet fraught with the substance of the sublimest truths that are attainable, in the sincere and disciplined pursuit of this knowledge. It is for us, then, who are privileged with the greater light, in addition to the better use of the less consequent on the experience of ages, reverently to acknowledge, on proper occasions, HIM to whom we are indebted for both; rejecting the subterfuges formerly employed to serve the purposes of a refined and sceptical philosophy, by men who **felt** their ignorance, while they pleased themselves with a parade of words: men, whose business it seems to have been, not so much to discover Truth, as by placing things in every possible light, in speculation, to prepare a Language for the use of those who should afterwards be permitted to unfold its mysteries. But even **they** did not always grovel thus — **Seneca** could say, "Nihil est aliud **Natura** quam Deus, et divina quaedam ratio, toti mundo et partibus ejus inserta." In which again (for Seneca was contemporary with **Paul**) we may trace the reflected image of revealed truth: "For the invisible things of Him from the creation of the world are clearly seen, being understood by the things that are made — even His Eternal power and Godhead." - *Rom*. i. 20.

The penmen of Holy Scripture were not qualified to instruct mankind in Natural philosophy nor was this their business; but to inculcate the more simple and important truths of Divine origin. They teach **Wisdom**, (the wisdom of conduct in human life:) and while they do this, they often allude to Creation, to Providence and Nature, in terms worthy of their inspiration, and of the subject. The latter part of the Book of **Job**, in particular, abounds in these allusions: with one of which, appropriate to our subject, I shall close these remarks:- "Whence then cometh Wisdom, and where is the place of understanding? - God understandeth the way thereof, and he knoweth the place thereof: For he looketh to the ends of the earth and seeth under the whole heaven, to make the weight for the winds: and he weigheth the waters by measure. When he made a decree for the rain, and a way for the lightning of the thunder, then did he see it and number it; he prepared it, yea searched it out. And unto man he said, Behold, the fear of the Lord, that is. Wisdom, and to depart from evil is understanding." - *Job* xxviii. 20, 23-28.

L.H.

Tottenham, Tenth Month, 25th, 1820.

ON THE MODIFICATIONS OF CLOUDS, AND ON THE PRINCIPLES OF THEIR PRODUCTION, SUSPENSION, AND DESTRUCTION; BEING THE SUBSTANCE OF AN ESSAY READ BEFORE THE ASKESIAN SOCIETY IN THE SESSION 1802-3.

SINCE the increased attention which has been given to Meteorology, the study of the various appearances of water suspended in the Atmosphere is become an interesting and even necessary branch of that pursuit.

If Clouds were the mere result of the condensation of Vapour in the masses of atmosphere which they occupy, if their variations were produced by the movements of the atmosphere alone, then indeed might the study of them be deemed an useless pursuit of shadows, an attempt to describe forms which, being the sport of winds, must be ever varying, and therefore not to be defined.

But however the erroneous admission of this opinion may have operated to prevent attention to them, the case is not so with Clouds. They are subject to certain distinct modifications, produced by the general causes which effect all the variations of the Atmosphere: they are commonly as good visible indications of the operation of these causes as is the countenance of the state of a person's mind or body.

It is the frequent observation of the countenance of the sky, and of its connexion with the present and ensuing phænomena, that constitutes the ancient and popular Meteorology. The want of this branch of knowledge renders the predictions of the Philosopher (who in attending only to his instruments may be said to examine only the **pulse** of the atmosphere) less generally successful than those of the weather-wise Mariner or Husbandman.

With the latter, the dependence of their labours on the state of the atmosphere, and the direction of its Currents, creates a necessity of frequent observation, which in its turn produces experience.

But as this experience is usually consigned only to the memory of the possessor, in a confused mass of simple aphorisms, the skill resulting from it is in a manner incommunicable; for, however valuable these links when in connexion with the rest of the Chain, they often serve, when taken singly, only to mislead; and the power of connecting them, and of forming a judgment upon occasion from them, resides only in the mind before which their relations have passed, though perhaps imperceptibly, in review. In order to enable the Meteorologist to apply the key of Analysis to the experience of others, as well as to record his own with brevity and precision, it may perhaps be allowable to introduce a Methodical nomenclature, applicable to the various forms of suspended water, or, in other words, to the Modifications of **Cloud**.

By modification is to be understood simply the Structure or manner of aggregation, not the precise form or magnitude, which indeed varies every moment in most Clouds. The principal Modifications are commonly as distinguishable from each other as a Tree from a Hill, or the latter from a Lake; although Clouds in the same modification, considered with respect to each other, have often only the common resemblances which exist among trees, hills, or lakes, taken generally.

The Nomenclature is drawn from the Latin. The reasons for having recourse to a dead language for Terms to be adopted by the learned of different nations are obvious. If it should be asked why the **Greek** was not preferred, after the example of Chemistry, the author answers, that the objects being to be defined by visible characters, as in Natural history, it was desirable that the Terms should at once convey the idea of these, and render a frequent recourse to definitions needless to such as understand the literal sense, which many more would, it is concluded, in Latin than in Greek words.

There are three simple and distinct Modifications, in any one of which the aggregate of minute drops called a Cloud **may be formed, increase to its greatest extent, and finally decrease and disappear**.

But the same Aggregate which has been formed in one Modification, upon a change in the attendant circumstances may pass into another:

Or it may continue for a considerable time in an intermediate state, partaking of the characters of two Modifications; and it may also disappear in this stage, or return to the first Modification.

Lastly, aggregates separately formed in different modifications may unite and pass into one exhibiting different characters in different parts, or a portion of a simple Aggregate may pass into another modification without separating from the remainder of the mass.

Hence, together with the simple, it becomes necessary to admit intermediate and compound Modifications; and to impose names on such of them as are worthy of notice.

The simple Modifications are thus named and defined:

1. CIRRUS.
   Def. *Nubes cirrata, tenussima, quæ undique crescat.*
   Parallel, flexuous, or diverging fibres, extensible by increase in any or in all directions.

2. CUMULUS.
   Def. *Nubes cumulata, densa, sursum crescens.*
   Convex or conical heaps, increasing upward from a horizontal base.

3. STRATUS.
   Def. *Nubes strata, aquæ modo expansa, deorsum crescens.*
   A widely extended, continuous, horizontal sheet, increasing from below upward.*

The intermediate Modifications which require to be noticed are:

4. CIRRO-CUMULUS.
   Def. *Nubeculæ densiores subrotundæ et quasi in agmine appositæ.*
   Small, well defined roundish masses, in close horizontal arrangement or contact.

5. CIRRO-STRATUS.
   Def. *Nubes extenuata subconcava vel undulata. Nubeculæ hujusmodi appositæ.*
   Horizontal or slightly inclined masses attenuated towards a part or the whole of their circumference, bent downward, or undulated; separate, or in groups consisting of small clouds having these characters.

The compound modifications are:

6. CUMULO-STRATUS.
   Def. *Nubes densa, basim planam undique supercrescens, vel cujus moles longinqua videtur partim plana partim cumulata.*
   The Cirro-stratus blended with the Cumulus, and either appearing intermixed with the heaps of the latter or **superadding a wide-spread structure to its base**.

7. CUMULO-CIRRO-STRATUS *vel.* Nimbus.
   Def. *Nubes vel nubium congeries* [superné cirrata] *pluviam effundens.*
   The Rain cloud. A cloud, or system of clouds from which rain is falling. It is a horizontal sheet, above which the Cirrus spreads, while the Cumulus enters it laterally and from beneath.

* This application of the Latin word **stratus** is a little forced. But the substantive **stratum**, did not agree in its termination with the other two, and is besides already used in a different sense even on this subject, e.g. **a stratum of clouds**; yet it was desirable to keep the derivation from the verb **sterno**, as its significations agree so well with the circumstances of this Cloud.

OF THE CIRRUS

Clouds in this Modification appear to have the least density, the greatest elevation, and the greatest variety of extent and direction. They are the earliest appearance after serene weather. They are first indicated by a few threads pencilled, as it were, on the sky. These increase in length, and new ones are in the mean time added to them. Often the first-formed threads serve as stems to sup-port numerous branches, which in their turn give rise to others.

The increase is sometimes perfectly indeterminate, at others it has a very decided direction. Thus the first few Threads being once formed, the remainder shall be propagated in one or more directions laterally, or obliquely upward or downward,* the direction being often the same in a great number of Clouds visible at the same time: for the oblique descending tufts appear to converge towards a point in the Horizon, and the long straight streaks to meet in opposite points therein; which is the optical effect of parallel extension.

Their **duration** is uncertain, varying from a few minutes after the first appearance to an extent of many hours. It is long when they appear alone and at great heights, and shorter when they are formed lower and in the vicinity of other Clouds.

This Modification, although in appearance almost motionless, is intimately connected with the variable motions of the atmosphere. Considering that Clouds of this kind have long been deemed a prognostic of wind, it is extraordinary that the nature of this connexion should not have been more studied; as the knowledge of it might have been productive of useful results.

In **fair** weather, with light variable breezes, the sky is seldom quite clear of small groups of the oblique Cirrus, which frequently come on from the leeward, and the direction of their increase is to windward. Continued **wet** weather is attended with horizontal sheets of this cloud, which subside quickly and pass into the Cirro-stratus.

Before **storms** they appear lower and denser, and usually in the quarter opposite to that from which the storm arises. Steady high winds are also preceded and attended by streaks running quite across the sky in the direction they blow in.

OF THE CUMULUS.

Clouds in this Modification are commonly of the most dense structure: they are formed in the lower atmosphere, and move along with the Current which is next the earth.

A small irregular spot first appears, and is, as it were, the **nucleus** on which they increase. The lower surface continues irregularly plane, while the upper rises into conical or hemispherical heaps; which may afterwards continue long nearly of the same bulk, or rapidly grow to the size of mountains.

In the former case they are usually numerous and near together, in the latter few and distant; but whether there are few or many, their **bases** lie always nearly in one horizontal plane; and their increase upward is somewhat proportionate to the extent of base, and nearly alike in many that appear at once.

Their appearance, increase, and disappearance, in **fair** weather, are often periodical, and keep pace with the Temperature of the day. Thus, they will begin to form some hours after sun-rise, arrive at their maximum in the hottest part of the afternoon, then go on diminishing, and totally disperse about sun-set.

But in **changeable** weather they partake of the vicissitudes of the atmosphere: sometimes evaporating almost as soon as formed; at others suddenly forming, and as quickly passing to the compound modifications.

* The upward direction of the fibres, or tufts of this Cloud is found to be a decided indication of the decomposition of vapour preceding rain: the downward as decidedly indicates evaporation and fair weather. In each case they point towards the place of the Electricity which is evolved at the time.

The Cumulus of **fair** weather has a moderate elevation and extent, and a well-defined rounded surface. Previous to **rain** it increases more rapidly, appears lower in the atmosphere, and with its surface full of loose fleeces or protuberances.

The formation of large Cumuli to leeward in a strong wind, indicates the approach of a calm with rain. When they do not disappear or subside about sun-set, but continue to rise, Thunder is to be expected in the night.

Independently of the beauty and magnificence it adds to the face of nature,* the Cumulus serves to screen the earth from the direct rays of the sun; by its multiplied reflections to diffuse, and, as it were, economise the Light, and also to convey the product of Evaporation to a distance from the place of its origin. The relations of the Cumulus with the state of the Barometer, &c. have not yet been enough attended to.

OF THE STRATUS

This Modification has a mean degree of density.

It is the **lowest** of Clouds, since its inferior surface commonly rests on the earth or water.

Contrary to the last, which may be considered as belonging to the **day**, this is properly the cloud of **night**; the time of its first appearance being about sun-set. It comprehends all those creeping Mists which in calm evenings ascend in spreading sheets (like an inundation) from the bottom of valleys and the surface of lakes, rivers, and other pieces of water, to cover the surrounding country.

Its **duration** is frequently through the night.

On the return of the sun the level surface of this Cloud begins to put on the appearance of Cumulus, the whole at the same time separating from the ground. The continuity is next destroyed, and the Cloud ascends and evaporates, or passes off with the morning breeze. This change has been long experienced as a prognostic of fair weather,† and indeed there is none more serene than that which is ushered in by it.

OF THE CIRRO-CUMULUS

The Cirrus having continued for some time increasing or stationary, usually passes either to the Cirro-cumulus or the Cirro-stratus, at the same time descending to a lower station in the atmosphere. The Cirro-cumulus is formed from a Cirrus, or from a number of small separate Cirri, by the fibres collapsing as it were, and passing into small roundish masses, in which the texture of the Cirrus is no longer discernible; although they still retain somewhat of the same relative arrangement. This change takes place either throughout the whole mass at once, or progressively from one extremity to the other. In either case, the same effect is produced on a number of adjacent Cirri at the same time and in the same order. It appears in some instances to be accelerated by the approach of other Clouds.

This Modification forms a very beautiful sky, sometimes exhibiting numerous distinct beds of these small connected clouds, floating at different altitudes.

The Cirro-cumulus is frequent in **summer**, and is attendant on warm and dry weather. It is also occasionally and more sparingly seen in the intervals of Showers, and in **winter**. It may either evaporate, or pass to the Cirrus or Cirro-stratus.

OF THE CIRRO-STRATUS.

This Cloud appears to result from the subsidence of the fibres of the Cirrus to a horizontal position, at the same time that they approach towards each other laterally. The form and relative position, when seen in the distance, frequently give the idea of shoals of fish. Yet in this, as in other instances, the **structure** must be attended to rather than the **form**, which varies much, presenting at

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* The connexion of the finer rounded forms, and more pleasing dispositions and colours of these Aggregates, with warmth and calmness; and of every thing that is dark and abrupt, and shaggy, and blotched, and horrid in them, with cold, and storm, and tempest, may be cited as no Mean instance of the perfection of that Wisdom and Benevolence which formed and sustains them.

† At nebulæ magis ima petunt, campoque recumbunt. *Virgil. Georg.* lib. i.

times the appearance of parallel bars, or interwoven streaks like the grain of polished wood. It is thick in the middle, and extenuated towards the edge. The distinct appearance of a Cirrus, however, does not always precede the production of this and the last Modification.

The Cirro-stratus precedes **wind** and **rain**, the near or distant approach of which may sometimes be estimated from its greater or less abundance and permanence. It is almost always to be seen in the intervals of storms. Sometimes this and the Cirro-cumulus appear together in the sky, and even alternate with each other in the same cloud; when the different evolutions which ensue are a curious spectacle; and a judgment may be formed of the weather likely to ensue by observing which Modification prevails at last. The Cirrostratus is the Modification which most frequently and completely exhibits the phænomena of the Solar and Lunar halo, and (as supposed from a few observations) the Parhelion and Paraselene also. Hence the reason of the prognostic of foul weather, commonly drawn from the appearance of Halo.*

This Modification is on this account more peculiarly worthy of investigation.

OF THE CUMULO-STRATUS.

The different Modifications which have been treated of some-times give place to each other, at other times two or more appear in the same sky; but in this case the Clouds in the same Modification lie mostly in the same plane, those which are more elevated appearing through the intervals of the lower, or the latter showing dark against the lighter ones above them. When the Cumulus increases rapidly, a Cirro-stratus is frequently seen to form around its summit, reposing thereon as on a mountain, while the former Cloud continues discernible in some degree through it. This state of things continues but a short time. The Cirrostratus speedily becomes denser and spreads, while the superior part of the Cumulus extends itself and passes into it, the base continuing as it was, while the convex protuberances change their position till they present themselves laterally and down. More rarely, the Cumulus performs this evolution by itself, and its superior part then constitutes the incumbent Cirro-stratus.

In either case a large lofty dense Cloud is formed, which may be compared to a Mushroom with a very thick short stem. But when a whole sky is crowded with this Modification, the appearances are indistinct. The Cumulus rises through the interstices of the superior Clouds; and the whole, seen as it passes off in the distant horizon, presents to the fancy mountains covered with snow, intersected with darker ridges, lakes of water rocks, and towers, &c. The **distinct** Cumulo-stratus is formed in the interval between the first appearance of the fleecy Cumulus and the commencement of rain, while the lower atmosphere is yet dry; also during the approach of Thunder-storms: the **indistinct** appearance of it is chiefly in the longer or shorter intervals of showers of rain, snow, or hail.

OF THE NIMBUS, OR CUMULO-CIRRO-STRATUS

Clouds in any one of the preceding Modifications, at the same degree of elevation, or in two or more of them at different elevations, may increase so as completely to obscure the sky; and may at times put on an appearance of density which to the inexperienced observer indicates the speedy commencement of rain. It is nevertheless extremely probable, as well from attentive observation as from a consideration of the several modes of their production, that **Clouds, while in any of these states, do not at any time let fall rain**.

Before this effect takes place they have been uniformly found to undergo a change, attended with appearances sufficiently remarkable to constitute a distinct Modification. These appearances, when the rain happens over-head, are but imperfectly seen. We can then only observe, before the arrival of the denser and lower Clouds, or through their interstices, that there exists **at a greater altitude** a thin light veil, or at least a hazy turbidness. When this has considerably increased, we see the lower Clouds spread themselves, till they unite in all points and form one uniform Sheet. The rain then commences; and the lower clouds, arriving from the windward, move under this Sheet, and are

* The frequent appearance of Halo in this cloud may be attributed to its possessing great extent, at such times with little perpendicular depth, and the requisite degree of continuity of substance.

successively lost in it. When the latter cease to arrive, or when the Sheet breaks, [letting through the sunbeams,] every one's experience teaches him to expect an abatement or cessation of **the rain**.

But there often follows, what seems hitherto to have been unnoticed, an immediate and great addition to the quantity of cloud. At the same time the actual obscurity is lessened, because the arrangement which now returns, gives freer passage to the rays of light: for on the cessation of rain, the lower broken clouds which remain rise into Cumuli, and the superior sheet puts on the various forms of the Cirro-status, sometimes passing to the Cirro-cumulus.

If the interval be long before the next shower, the Cumulo-stratus usually makes its appearances; which it also does sometimes very suddenly after the first cessation.

But we see the nature of this process more perfectly in viewing a distant shower in profile.

If the Cumulus be the only cloud present at such a time, we may observe its superior part to become tufted with nascent Cirri. Several adjacent Clouds also approach and unite laterally by subsidence.

The Cirri increase, extending themselves upward and laterally, after which the shower is seen to commence. At other times, the converse takes place of what had been described relative to the cessation of rain. The Cirro-stratus is previously formed above the Cumulus, and their sudden union is attended with the production of Cirri and rain.

In either case the Cirri **vegetate**, as it were, in proportion to the quantity of rain falling, and give the cloud a character by which it is easily known at great distances and to which, in the language of Meteorology, we may appropriate the Latins.*

When one of these arrives hastily **with the wind** it brings but little rain, and frequently some hail or driven snow.

In heavy showers, the central Sheet once formed, is, as it were, warped to windward, the Cirri being propagated above and against the lower current, while the Cumuli arriving with the latter are successively **brought to**, and contribute to reinforce it.

Such are the phænomena of **showers**. In continued gentle rains it does not appear necessary for the resolution of the Clouds that the different Modifications should come into actual contact.

It is sufficient that there exist two strata of Clouds, one passing beneath the other, and each continually tending to horizontal uniform diffusion.† It will rain during this state of the two strata, although they should be separated by an interval of many hundred feet in elevation. See an instance in De Luc, *Idées sur la Météorologie*, tom. ii. p.52, &c. [It is not to be supposed that the intermediate space is, on these occasions, at any time free from a conducting medium of diffused watery particles, enabling the opposite Electricities to neutralize each other.]

As the masses of Cloud are always blended, and their arrangements broken up before rain comes on, so the reappearance of these is the signal for its cessation. The thin sheets of Cloud which pass over during a wet day, certainly receive from the humid atmosphere a supply proportionate to their consumption, while the latter prevents their increase in bulk. Hence a seeming paradox, which yet accords strictly with observation, that for any given hour of a wet day, or any given day of a wet season, **the more cloud the less rain**. Hence also arise some further reflections on the purpose answered by Clouds in the Economy of nature. Since rain may be produced by, and continue to fall from, the slightest obscuration of the sky by the Nimbus (or by two sheets in different states,) while the Cumulus or Cumulo-stratus, with the most dark and threatening aspect, shall pass over without letting fall a drop, until the change of state commences, it should seem that the latter are Reservoirs [water-waggons they are called by some] in which the water is collected from a large space of atmosphere for occasional and local irrigation in dry seasons, and by means of which it is also arrested at times in its descent in the midst of wet ones. In which so evident provision for the sustenance of all animal and vegetable life, as well as for the success of mankind in that pursuit so

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Qualis ubi ad terms abrupto sidere *nimbus*
It mare par medium, miseris heu *prescia longe*
Horrescunt corda agricolis. - *Virgil.*

† The superior stratum is often seen, in this case, to partake of the Cirrus.

essential to their welfare, in temperate climates, of cultivating the earth, we may discover the wisdom and goodness of the Creator and Preserver of all things.

The Nimbus, although in itself one of the least beautiful Clouds, is yet now and then superbly decorated with its attendant the rainbow; which is seen in perfection when backed by the widely-extended uniform gloom of this Modification.

The relations of rain, and of periodical showers more especially, to the varying Temperature, Density, and Electricity of the atmosphere, will now probably obtain a fuller investigation, and with a better prospect of success, than heretofore.

As the establishing distinctive characters for Clouds has been heretofore deemed a desirable object, and it is consequently probable that the author's Modifications will begin to be noted in Meteorological registers as they occur, (a practice which may be productive of considerable advantage to science,) the following System of abbreviations may, perhaps, be found of some use in this respect. They will save room and the labour of writing, and types may be easily formed for printing them. These are advantages not to be despised, when observations are to be noted once or oftener in the day. It is only necessary that they be inserted in a column headed **Clouds**; that the Modifications which appear together be placed side by side, and those which succeed to each other in the order of the column, but separated by a line or space from the preceding and succeeding day's notations.

\ Cirrus: ∩ Cumulus: __ Stratus: \∩ Cirro-cumulus: __ Cirro-stratus:
∩__ Cumulo-stratus: \∩__ Cirro-cumulo-stratus, or Nimbus.

[In my first publication on Clouds, I was induced, by a supposed necessity arising from the novelty of the subject, to add to the definitions a set of plates, of the several modifications. I have now decided to omit these representations: being satisfied, both by reflection and experience, that the real student will acquire his knowledge in a more solid manner, by the observation of nature, without the aid of drawings, and that the more superficial are liable to be led into error by them.]

In tracing the various appearances of clouds, we have only adverted to their connexion with the different states of the atmosphere, (on which, indeed, their diversity in a great measure depends,) having purposely avoided mixing difficult and doubtful explanation with a simple descriptive arrangement.

OF EVAPORATION.

On the remote and universal origin of clouds there can be but one opinion — that the water of which they consist has been carried into the atmosphere by Evaporation. It is on the nature of this process, the state in which the Vapour subsists for a time, and the means by which the Water becomes again visible, that the greatest diversity of opinion has prevailed,

The Chemical philosopher, seduced by analogy, and accustomed more to the action of liquids on solids, naturally regards Evaporation as a solution of water in the atmosphere, and the appearance of cloud as the first sign of its precipitation; which becoming afterwards (under favourable circumstances) more abundant, produces rain. The theory of Dr. Hutton goes a step further, assumes a certain rate of solution differing from that of the advance of temperature by which it is effected, and deduces a general explanation of clouds and rain from the precipitation which, according to his rule, should result from every mixture of different portions of saturated air. The fundamental principle of this theory has been disproved in an essay heretofore presented to the Society,[*] and

[*] See Phil. Mag. vol. xiv. p.55.

which was written under the opinion, at present generally adopted by chemists, that evaporation depends on a solvent power in the atmosphere, and follows the general rules of chemical solution.

The author has since espoused a theory of evaporation which altogether excludes the above-named opinion, (and consequently Dr. Hutton's also,) and considers himself in a great degree indebted to it for the origin of the explanation he is about to offer. It will be proper, therefore, to state the fundamental propositions of this theory, with such other parts as appear immediately necessary, referring for mathematical demonstrations and detail of experiments to the work itself, which is entitled "Experimental Essays on the Constitution of mixed Gases; on the Force of Steam or Vapour from Water and other Liquids in different Temperatures, both in a Torricellian Vacuum and in Air; on Evaporation; and on the Expansion of Elastic Fluids by Heat. By John Dalton."- See Memoirs of the Literary and Philosophical Society of Manchester, vol. v. part 2.

The propositions are as follows:

"1. When two elastic fluids, denoted by **A** and **B**, are mixed together, there is no mutual repulsion amongst their particles; that is, the particles of **A** do not repel those of **B**, as they do one another. Consequently, the pressure or whole weight upon any one particle arises solely from those of its own kind.

"2. The force of steam from all liquids is the same at equal distances above or below the several temperatures at which they boil in the open air: and that force is the same under any pressure of another elastic fluid as it is *in vacuo*. Thus the force of aqueous vapour of 212° is equal to 30 inches of mercury; at 30° below, or 182°, it is of half that force; and at 40 above, or 252°, it is of double the force. So likewise the vapour from Sulphuric ether, which boils at 102° then supporting 30 inches of mercury, at 30° below that temperature has half the force, and at 40° above, double the force: and so in other liquids. Moreover, the force of aqueous vapour of 60° is nearly equal to half an inch of mercury when admitted into a Torricellian vacuum: and water of the same temperature, confined with perfectly dry air, increases the elasticity to just the same amount.

"3. The quantity of any liquid evaporated in the open air is directly as the force of steam from such liquid at its temperature, all other circumstances being the same."

The following is part of the Essay on Evaporation.

"When a liquid is exposed to the air, it becomes gradually dissipated in it: the process by which this effect is produced we call **Evaporation**.

"Many Philosophers concur in the theory of chemical solution. Atmospheric air, it is said, has an affinity for water; it is a menstruum in which water is soluble to a certain degree. It is allowed notwithstanding by all, that each liquid is convertible into an elastic vapour *in vacuo*, which can subsist independently in any temperature. But as the utmost forces of these vapours are inferior to the pressure of the atmosphere in ordinary temperatures, they are supposed to be incapable of existing in it in the same way as they do in a Torricellian vacuum: hence the notion of affinity is induced; According to this theory of Evaporation, atmospheric air (and every other species of air for aught that appears) dissolves water, alcohol, ether, acids, and even metals. Water below 212° is chemically combined with the gases. Above 212° it assumes a new form, and becomes a distinct elastic fluid, called **steam**. Whether water first chemically combined with air, and then heated above 212°, is detached from the air or remains with it, the advocates of the theory have not determined. This theory has always been considered as complex, and attended with difficulties; so much so, that M. Pictet and others have rejected it, and adopted that which admits of distinct elastic vapours in the atmosphere at all temperatures, uncombined with either of the principal constituent gases; as being much more simple and easy of explication than the other: though they do not remove the grand objection to it, arising from atmospheric pressure."

"ON THE EVAPORATION OF WATER BELOW 212°.

"I have frequently tried the Evaporation at all the temperatures below 212°. It would be tedious to enter into a detail of all the experiments, but I shall give the results at some remarkable points.

"The evaporation from water of 180° was from 18 to 22 grains per minute, according to circumstances; or about one-half of that at 212°.

"At 164° it was about one-third of the quantity at the boiling temperature, or from 10 to 16 grains per minute.

"At 152° it was only one fourth of that at boiling, or from 8 to 12 grains, according to circumstances.

"The temperature of 144° affords one-fifth of the effect at boiling; 138° gave one sixth, &c.

"Having previously to these experiments determined the force of aqueous vapour at all the temperatures under 212°, I was naturally led to examine whether the quantity of water evaporated in a given time bore any proportion to the force of vapour of the same temperature, and was agreeably surprised to find that they exactly corresponded in every part of the thermometric scale: thus the forces of vapour at 212°, 180°, 164°, 152°, 144°, and 138°, are equal to 30, 15, 10, 7½, 6, and 5 inches of mercury respectively; and the grains of water evaporated per minute in those temperatures were 30, 15, 10, 7½, 6, and 5, also; or numbers proportional to these. Indeed it should be so, from the established law of mechanics that all effects are proportional to the causes producing them. The atmosphere, it should seem, obstructs the diffusion of vapour, which would otherwise be almost instantaneous, as *in vacuo*; but this obstruction is overcome in proportion to the force of the vapour. The obstruction, however, cannot arise from the weight of the atmosphere, as has till now been supposed; for then it would effectually prevent any vapour from rising under 212°; but it is caused by the *vis inertiæ* of the particles of air, and is similar to that which a stream of water meets with in descending amongst pebbles.

"The theory of evaporation being thus manifested from experiments in high temperatures, I found that if it was to be verified by experiments in low temperatures, regard must be had to the force of vapour actually existing in the atmosphere at the time. For instance, if water of 59° were the subject, the force of vapour of that temperature is $\frac{1}{60}$th of the force at 212°, and one might expect the quantity of evaporation $\frac{1}{60}$th also. But if it should happen, as it sometimes does in summer, that an aqueous atmosphere to that amount does already exist, the evaporation, instead of being $\frac{1}{60}$th of that from boiling water, would be nothing at all. On the other hand, if the aqueous atmosphere were less than that, suppose one half of it, corresponding to 39° of heat, then the effective evaporating force would be $\frac{1}{120}$th of that from boiling water. In short, the evaporating force must be universally equal to that of the temperature of the water, diminished by that already existing in the atmosphere.

In order to find the force of the aqueous atmosphere I usually take a tall cylindrical glass jar, dry on the outside, and fill it with cold spring water fresh from the well. If dew be immediately formed on the outside, I pour the water out, let it stand awhile to increase in heat, dry the outside of the glass well with a linen cloth, and then pour the water in again. This operation is to be continued till dew ceases to be formed, and then the temperature of the water must be observed; and opposite to it in the table will be found the force of vapour in the atmosphere. This must done in the open air, or at a window; because the air within is generally more humid than that without. Spring water is generally about 50°, and will mostly answer the purpose the three hottest months in the year; in other seasons an artificial cold mixture is required. The accuracy of the result obtained this way, I think, scarcely needs to be insisted on. Glass, and all other hard, smooth substances I have tried, when cooled to a degree below what the surrounding aqueous vapour can support, cause it to be condensed on their surfaces into water. The degree of cold is usually from 1 to 10° below the mean heat of the twenty-four hours; in summer I have often observed the point as high as 58° or 59°, corresponding to half an inch of mercury in force; and once, or twice have seen it at 62°. In changeable and windy weather it is liable to a considerable fluctuation; but this is not the place to enlarge upon it.

"For the purpose of observing the Evaporation in atmospheric temperatures, I got two light tin vessels, the one six inches in diameter and half an inch deep, the other eight inches diameter and three-fourths of an inch deep, and made to be suspended from a balance. When any experiment, designed as a test of the theory, was made, a quantity of water was put into one of these, (generally the six-inch one, which I preferred,) the whole was weighed to a grain; then it was placed in an open window or other exposed situation for ten or fifteen minutes, and again weighed to ascertain the loss by evaporation: at the same time the temperature of the water was observed, the force of the aqueous atmosphere ascertained as above, and the strength of the current of air noticed. From a great variety of experiments made both in the winter and summer, and when the evaporating force was strong and weak, I have found the results entirely conformable with the above theory. The same quantity is evaporated with the same evaporating force thus determined, whatever be the temperature of the air, as near as can be judged; but with the same evaporating force, a strong wind will double the effect produced in a still atmosphere. Thus, if the aqueous atmosphere be correspondent to 40° of temperature and the air be 60°, the evaporation is the same as if the aqueous atmosphere were at 60° of temperature and the air 72°; and in a calm air the evaporation from a vessel of six inches in diameter, in such circumstances, would be about 0.9 of a grain per minute, and about 1.8 grains per minute in a very strong wind; the different intermediate quantities being regulated solely by the force of the wind."

OF THE AQUEOUS ATMOPSHERE

Having quoted so much of this essay as may suffice to exhibit the principles on which we shall proceed, it may be useful, before we do this, to recapitulate the following circumstances respecting the atmosphere of aqueous gas, or (for brevity) the Aqueous atmosphere.

1st. It is supplied by the process of Evaporation, which by this theory appears to be reduced to the immediate union of water with Caloric into a binary compound, **Aqueous gas**.

2dly. The supply of vapour (by which term, for the purposes of Meteorology, we may denote aqueous gas) is regulated by the following circumstances:- 1. Temperature of the evaporating water; being greater as this is higher, and *vice versâ*. 2. Quantity of surface exposed. Since it is from the surface only of the mass that the vapour in common cases can escape, the supply is in direct proportion thereto. 3. Quantity of vapour already subsisting in the atmosphere: the evaporation being less (with an equal temperature and surface) in proportion as this is greater, and *vice versâ*.

3dly. The vapour thus thrown into the atmosphere is diffusible therein by its own elasticity: which suffices for its ascent to any height in a perfect calm. Yet, as in this case the **inertia** of the particles of air considerably resists its diffusion, so in the opposite one of a brisk current, the vapour, by the same rule, must in some measure be drawn along with the mass into which it enters.

4thly. The quantity of vapour which, under equal pressure, can subsist in a given mass of air, will be greater as the common temperature is higher, and *vice versâ*.*

Aqueous vapour is the only gas contained in the atmosphere which is subject to very sensible variations in quantity. These variations arise from its attraction for caloric being inferior to that of all the others. Hence when a cold body, such as the glass of water in the experiment above quoted, is presented to the atmosphere, the other gases will only be cooled by it (and that at all known temperatures); but the vapour, after being more or less cooled, will begin to be decomposed, its caloric entering the body while the water is left on the surface.

* "The aqueous vapour atmosphere is variable in quantity according to temperature; in the torrid zone its pressure on the surface of the earth is equal to the force of .6, and from that to one inch of mercury. In these parts it rarely amounts to the pressure of .6, but I have frequently observed it above half an inch in summer; in winter it is sometimes so low as to be of no more force than .1 of an inch of mercury, or even half a tenth, in this latitude, and consequently much less where the cold is more severe. This want of equilibrium in the aqueous vapour atmosphere is a principal cause of that constant inundation of it into the temperate and frigid zones, where it becomes in part condensed in its progress by the cold, (like the vapour of distillation in the worm of a refrigeratory,) and supplies the earth with rain and dew." - See the Essays above quoted.

The formation of Cloud is in all cases the **remote** consequence of a decomposition thus effected, the caloric escaping not into a solid or liquid, but into the surrounding gases.

OF THE FORMATION OF DEW

Dew is the **immediate** result of this decomposition. The particles of water constituting it are, singly, invisible, on account of their extreme minuteness. The approach of dew is, nevertheless, discoverable by a dark hazy appearance, verging from purple to faint red, extending from the horizon to a small distance upward, and most conspicuous over valleys and large pieces of water.

The theory of dew seems to be simply this:- During the heat of the day a great quantity of vapour is thrown into the atmosphere from the surface of the earth and waters. When the evening returns, if the vapour has not been carried off in part by currents, it will often happen that more remains diffused in the general atmosphere than the temperature of the night will permit to subsist under the full pressure of the aqueous atmosphere. A decomposition of the latter then commences, and is continued until the general temperature and aqueous pressure arrive at an equilibrium, or until the returning sun puts an end to the process. The caloric of the decomposed vapour goes to maintain the general temperature; while the water is separated in drops; which, minute as they are, arrive successively at the earth in the space of a few hours. That the ordinary production of dew is by a real descent of water from the atmosphere, and not by decomposition of vapour on surfaces previously cooled, (as in the experiment already mentioned,) any one may readily be convinced by observing in what abundance it is collected by substances which are wholly unfit to carry off the requisite quantity of caloric for the latter effect.

OF THE FORMATION OF THE STRATUS

The case which has been just stated, **of the decomposition of vapour by the atmosphere in which it is already diffused**, goes but a little way in explanation of the production of a Cloud consisting of visible drops, and confined to a certain space in the atmosphere: much less does it enable us to account for the diversity of its situations and appearances. In attempting this we will begin with the Stratus, as the most simple in structure, and the next step, as it were, in the progress of **nubification**.

When dew falls upon a surface the temperature of which is superior to that of the atmosphere, it is plain that it will not continue there, but will be evaporated again: and a body so circumstanced will continue to refund into the atmosphere the whole of the water thus **gradually** deposited on it, so long as its substance can supply the requisite temperature to the surface. Moreover, water, either in mass or diffused among sand, clay, vegetable earth, &c. will continue to be evaporated therefrom with a force proportioned to its temperature, so long as the latter continues above that point which counterbalances the pressure of the Aqueous atmosphere.

From these causes it happens, that after the earth has been superficially dried by a continuance of sunshine, and heated, together with the lakes and rivers, to a considerable depth, there is an almost continual emission of vapour into the atmosphere by night.

This nocturnal evaporation is usually most powerful in the autumn, about the time that the temperature of the nights undergoes a considerable and sometimes pretty sudden depression, attended with a calm.*

In this state of things the vapour arising from the heated earth is condensed **in the act of diffusing itself**: the cold particles of water thus formed, in **descending**, meet the ascending stream of vapour, and condense a portion on their surfaces. If they touch the earth they are again evaporated, which is not necessarily the case if they alight on the herbage. In this way an aggregate of visible drops is sooner or later formed: and as from the temperature thus communicated to the air

* A plentiful dew may often be found on the grass after a Stratus.

next the earth, the vapour has still further and further to rise in order to be condensed, the cloud will be propagated upward in proportion.

Hence the Stratus most usually makes its appearance in the evening succeeding a clear warm day, and in that quiescent state of the atmosphere which attends a succession of these. Hence also the frequency of it during the penetration of the autumnal rains into the earth; while in Spring, when the latter is **acquiring** temperature together with the atmosphere, it is [more] rarely seen.

OF THE FORMATION OF THE CUMULUS

When the sun's rays traverse a clear space of atmosphere, it is well known that they communicate no sensible increase of temperature thereto. It is by the contact, and what may be termed the **radiation**, of opake substances exposed to the light, that Caloric is thrown into the atmosphere.

This effect is first produced on the air adjacent to the earth's surface; and proceeds upward, more or less rapidly, according to the season and other attendant circumstances. In the morning, therefore, Evaporation usually prevails again; and the vapour, which continues to be thrown into air now increasing in temperature, is no longer condensed. On the contrary, it exerts its elastic force on that which the nocturnal temperature had not been able to decompose, and which consequently remained universally diffused. The latter, in rising **through the atmosphere** to give place to the supply from below, must necessarily change its climate, quit the lower air of equal temperature, and arrive among more elevated and colder air; the pressure from above still continuing unabated. The consequence is a partial decomposition, extending through the portion thus thrown up, and, in short, a recommencement in the superior region, of the same process which in the vicinity of the earth furnished the dew of the night. In this case, however, the particles of water cannot arrive at the earth, as they are necessarily evaporated again in their descent.

It appears that this second Evaporation takes place at that elevation where the temperature derived from the action, of the sun's rays upon the earth, and decreasing upward, becomes just sufficient to counterbalance the pressure of the superior vapour.

Here is formed a sort of boundary between the region of cloud and the region of permanent vapour, which for the present purpose, and until we are furnished with a nomenclature for the whole science of Meteorology, may be denominated the Vapour plane.

Immediately above the Vapour plane, then, the formation of the Cumulus commences (as soon as a sufficient quantity of vapour has been thrown up) by the mixture of descending minute drops of water with vapour newly formed and just diffusing itself, as in the case of the Stratus before described.

A continuance of this process might be expected to produce a uniform sheet of cloud; in short, a Stratus, only differing in situation from the true one. Instead of which we see the first-formed small masses become so many centres, towards which all the water afterwards precipitated appears to be attracted from the space surrounding them; and this attraction becomes more powerful as the cloud increases in magnitude, insomuch that the small clouds previously formed disappear when a large one approaches them in its increase, and seem to vanish instead of joining it. This is probably owing to the small drops composing them having passed in a loose manner and successively, by attraction, into the large one.

Are the distinct masses into which the drops form themselves, in this case, due to the attraction of aggregation alone, or is the operation of any other cause to be admitted?

A rigid mathematician would perhaps answer the latter clause in the negative; and with such a conclusion we should have great reason to remain satisfied, as cutting short much of the inquiry that is to follow, were it not that it leaves us quite in the dark, both as to the cause of the variety so readily observable in clouds, and that of their long suspension, not to insist on several facts contained in the former part of this paper, which would then remain unaccounted for.

The operation of one simple principle would produce an effect at all times **uniform**, and varying only in degree. We should then see no diversity in clouds but in their magnitude; and the same attraction that could bring minute drops of water together through a considerable space of atmosphere in a few minutes, ought not to end there, but to effect their perfect union into larger, and finally into rain.

In admitting the constant operation of Electricity, which is at times so manifestly accumulated in clouds, upon their forms and arrangements, we shall not much overstep the limits of experimental inquiry, since it has been ascertained by several eminent philosophers, that "clouds, as well as rain, snow, and hail, that fall from them, are almost always electrified."*

An insulated Conductor formed of solid matter retains the charge given to it so much the longer, as it is more nearly spherical, and free from points and projecting parts. The particles of water, when charged, appear to make an effort to separate from each other, or, in other words, become mutually repulsive. Moreover, when a small conducting substance is brought within the reach of a large one similarly electrified, the latter, instead of repelling, will throw the small one into an opposite state, and then attract it. From these and other well-known facts in Electricity it would not be difficult to show, that an assemblage of particles of water floating in the atmosphere, and similarly electrified, ought to arrange themselves in a spherical aggregate, into which all the surrounding particles of water (within a certain distance) should be attracted; at the same time that the drops composing such aggregate should be absolutely prevented from uniting with each other **during the equilibrium of their electricity**.

To apply this reasoning to the formation of the Cumulus, we may, in the first place, admit that the commencement of distinct aggregation, in the descending particles of water, is due to their mutual attraction; by virtue of which small bodies, floating in any medium, tend to coalesce. The masses thus formed, however, often increase more rapidly than could be expected from the effect of simple attraction exercised at great distances. And when the cloud has arrived at a considerable size, its protuberances are seen to form, and successively sink down into the mass, in a manner which forces one to suppose a shower of invisible drops rushing upon it from all parts.

In unsettled weather the rapid formation of large Cumuli has been observed to clear the sky of a considerable hazy whiteness; which on the other hand has been found to ensue upon their **dispersion**.†

On these considerations we are obliged to admit as a co-operating cause of the increase of this cloud, that sort of attraction which large insulated conducting masses exercise, when charged, on the smaller ones which lie within their influence. Instead of a **spherical** aggregate, however, we have only a sort of hemisphere; because that part of the cloud which presents itself toward the earth can receive no addition from beneath; there being in that direction no condensed water. On the contrary, the mass must be continually suffering a diminution there, by the tendency of the cloud to subside and of the vapour plane to rise, during the increase of the diurnal temperature. It is this evaporation that cuts off all the Cumuli visible at one time in the same plane; and it is reasonable to conclude that much of the vapour thus produced is again condensed without quitting the cloud, as its course would naturally be mostly upward. Thus the drops of which a Cumulus consists may become larger the longer it is suspended, and the electricity stronger from the comparative diminution of surface.

Such is probably the manner in which this curious structure is raised, while the base is continually escaping from beneath it. That we may not however be accused of building a castle in the air by attempting further conjectures, we may leave the present Modification, after recapitulating some of its circumstances which appear to be accounted for.

The Cumulus is formed only in the day time, because the direct action of the sun's rays upon the earth can alone put the atmosphere into that state of inequality of temperature which has been described. It evaporates in the evening from the cessation of this inequality, the superior atmosphere

* Cavallo Complete Treatise on Electricity, vol. i. p.74.

† That clouds are not always **evaporated** when they disappear, but sometimes dispersed so as to become invisible as distinct aggregates, is a fact pretty well ascertained by observation. This happens sometimes by the approach of other clouds; at others, the evaporation of part of a Cumulus is followed by the dispersion of the remainder. The criterion used was the speedy production of transparency in the one case, and of hazy turbidness in the other.

having become warmer, the inferior colder, attended with a decrease of the superficial Evaporation. It begins to form some hours after sunrise, because the vapour requires that space of time to become elevated by the gradual accession from below. When a **Stratus** covers the ground at sunrise, however, we often see it collect into Cumuli upon the Evaporation of that part of it which is immediately contiguous to the earth. And this ought to happen; for the Cloud is then insulated, the vapour-plane is established, and every thing in the same state (except in point of elevation) as in the ordinary mode of production of the Cumulus.

Lastly, the Cumulus, however dense it becomes, does not afford Rain, because it consists of drops similarly electrified and repelling each other; and is moreover continually evaporating, from the plane of its Base. The change of form which comes on before it falls in Rain, and which indicates a disturbance of its Electrical state, will be noticed hereafter.

OF THE FORMATION OF THE CIRRUS

It must have been owing entirely to the want of distinctive characters for clouds, and the consequent neglect of observing their changes, that the nature of this Modification more especially has not engaged the attention of Electricians. The attraction of aggregation operating on solid particles diffused in fluids, does indeed produce a great variety of ramifications in the process of crystallization: but these are either uniform in each substance, or have a limited number of changes. And in no instance do we see the same substance, separating from the same medium and unconfined in its movements, rival the numerous metamorphoses of the Cirrus.

The great elevation of these clouds in their ordinary mode of appearance has been ascertained both by geometrical observations,* and by viewing them from the summits of the highest mountains, when they appear as if seen from the plain. A more easy and not less convincing proof may be had by noting the time during which they continue to reflect the different coloured rays after sunset; which they do incomparably longer than any others. The same configuration of Cirrus has been observed in the same quarter of the sky for two successive days, during which a smart breeze from the opposite quarter prevailed below.

It is therefore probable that this Modification collects its water in a comparatively, calm region; which is sometimes incumbent on the current next the earth, and almost out of the reach of its **daily** variations in temperature and quantity of vapour; but at other times is interposed between the latter and a supervening current from another climate; in which case it may be affected by both currents.

The Cumulus has been just now considered as an insulated body, consisting of moveable parts which accommodate themselves to the state of a **retained** Electricity. We shall attempt to explain the nature of the Cirrus by comparing it to those imperfect conductors, which being interposed between Electrics and Conductors, or between the latter in different states, serve to restore by degrees the equilibrium of the Electric fluid.

If a lock of hair be properly fixed on the prime conductor and electrified **plus**, the hairs will be separately extended at as great a distance from each other as possible; in which state they will continue some time. The reason appears to be, that the contiguous air is then **minus**; and consequently these two moveable substances put themselves into the state most favourable to a communication which is going on slowly between bad conductors.

The same appearances will take place if the lock be electrified **minus**, the contiguous air being **plus**; and in each case the hairs will move **from** a body similarly electrified and brought near them, and **towards** one contrariwise electrified. Moreover, if we could insulate such a charged lock in the midst of a perfectly tranquil atmosphere of sufficient extent, in which particles of conducting matter were suspended, it is plain the latter would be attracted by it so long as the charge continued; after which they would be at large as before.

* "The small white streaks of condensed vapour which appear on the face of the sky in serene weather, I have, by several careful observations, found to be from three to five miles above the earth's surface." - DALTON.

Dry air being an electric, and moist air but an indifferent conductor, it is reasonable to suppose that an immediate communication of Electricity between masses of air differently charged can scarcely happen to any great extent, except by the intimate mixture of such masses; an effect which may possibly follow in some cases, and occasion strong winds and commotions in the atmosphere. If we consider how frequently, and to what an extent, the Electricity of the air is disturbed (as appears from numerous experiments) by evaporation, by the formation and passage of clouds, by elevation or depression of temperature, (by friction upon surfaces of ice?) it seems probable that the particles of water floating in a calm space may be frequently converted into conductors; by which the equilibrium is in part restored after such disturbance.

Viewing the Cirrus in this light, it becomes important for those who are well versed in electricity to study its appearances, and compare them with the changes that ensue in the atmosphere. A number of observations, made hitherto chiefly in one place, and without system or aid from concurrent ones in others, have furnished the preceding data, which may serve as hints for future investigation.

At present we can only conjecture that the local detached Cirri which ramify **in all directions**, are collecting particles of water from the surrounding space; and at the same time equalizing their own electricity with that of the air or vapour.

That when numerous oblique short tufts appear, they are conducting between the air above and that below them.

That a decided direction of the extremities of pendent or erected Cirri from the mass they join towards any quarter, is occasioned by the different Electricity of a current of air which is pressing upon the space they are contained in. This is the most important point to attend to, as these **tails** sometimes veer half round the compass in the course of a few hours: and many observations have confirmed the fact that they point **towards the coming wind**, and are larger and lower as this is about to be stronger.

Lastly, the Cirri in parallel lines, stretching from horizon to horizon, denote a communication of Electricity carried on through these clouds **over** the place of observation; the two predisposed masses of atmosphere being very distant, and the intermediate lower atmosphere not in a state to conduct it. It is at least a circumstance well deserving inquiry, by what means the clouds in stormy seasons become arranged in these elevated parallel bars; which must be at least sixty miles long, and are probably much more, considering their elevation and that both extremities are often invisible.

OF THE NATURE OF THE INTERMEDIATE MODIFICATIONS.

The conversion of the Cirrus into the Cirro-cumulus is a phænomenon which at some seasons may be daily traced, and which serves to confirm the opinion that there exists somewhat of the same difference between the Cumulus and the Cirrus, as between a **charged** and a **transmitting**, or an influenced, conductor, among solid bodies. On this supposition, the orbicular arrangement of the particles ought to take place as soon as the mass has ceased to conduct from particle to particle, or to be so acted on by a contiguous conductor as to have a **plus** and **minus** state within itself. And as this sort of communication in a cloud may be as slow as in other imperfect conductors, the equilibrium among the particles may be restored at one extremity some time before the other has ceased to transmit; whence a visible progress of the change, which may be traced in a Cirrus of sufficient length.

That an extensive horizontal Cirrus should become divided across its length, and that these divided parts should assume more or less of a round form, is also consistent with the idea of a change of this sort.* It is not so easy to give a reason why these small orbicular masses should remain in close arrangement, or even in contact, for several hours, forming a system of small clouds which

* A quickly evaporating Cumulus sometimes leaves a regular Cirrus behind, formed out of the remnant of the cloud, which, in the intermediate state, and just when it begins to show the sky through it, exactly represents the pores and fibre of a **sponge**. [What is also curious, this appearance is a decided indication of drought approaching.]

yet do not interfere with each other or run together into one, but remain as it were in readiness to re-form the Cirrus; which sometimes happens very suddenly, though they more frequently evaporate by degrees.

The same remark applies to the curious, and as it were capricious divisions and subdivisions, both longitudinal and transverse, which happen in the Cirro-stratus when this cloud is verging towards the Cirro-cumulus. In general, nevertheless, its appearance is sufficiently distinct from that of the Cirrus and Cirro-cumulus. The Cirrus by the great extent in proportion to its mass, its distinct lines and angular flexures, and the Cirro-cumulus by the roundness and softness of its forms, indicates an essential difference in the state of the containing atmosphere. The Cirro-stratus appears to be always in a subsiding state, and to be more feebly acted on by Electricity than the preceding Modifications. Indeed, the lower atmosphere is usually pretty much charged with dew or haze at the time of its appearance, and therefore in a state to conduct a charge to the earth.

OF THE NATURE OF THE COMPOUND MODIFICATION, AND OF THE RESOLUTIONS OF CLOUDS INTO RAIN

From the theory of Evaporation it appears that no permanent cloud can be formed in the atmosphere, however low the temperature, without a sufficient pressure from vapour previously diffused. Hence, although in cold weather the breath and perspiration of animals, as also water at a certain excess of temperature, occasion a visible cloud, yet this cloud speedily evaporates again at all times, except when precipitation is actually going on at large in the atmosphere next the ground; when it is only **dispersed** therein. By comparing the different effects of a clear frosty air, and of a misty though much warmer one, on the perspiration and breath of horses warmed by labour, we may be assisted in reasoning on the great ease of Evaporation, which, in some sense, is the **perspiration** of the earth.

The most powerful predisposing cause of Evaporation appears to be a superior current in the atmosphere, coming from a region where the low temperature of the surface, or its dry state, occasions a comparative deficiency of vapour. Hence, after heavy rain in winter, we see the sudden Evaporation, first of the remaining clouds, then of the water on the ground, followed by a brisk Northerly wind and sharp frost.

The very snow which had fallen on its arrival sometimes totally evaporates during the prevalence of such a wind: On the contrary, the first appearance of clouds forming in cold weather gives us to expect a speedy, remission of the frost, although the cause is not generally known to be a change to a Southerly direction already begun in the superior atmosphere; which consequently brings on an excess of vapour.

This excess of vapour, coming with a superior current, may be placed next to depression of temperature among the causes of Rain. The simultaneous decomposition of the higher **imported** vapour, and of that which is formed on the spot, or already diffused in the inferior current, would necessarily produce two orders of cloud; differing more or less in electricity as well as in other respects. To the slow action of these upon each other, while Evaporation continues below, may be attributed the singular union which constitutes the Cumulo-stratus. It is too early to attempt to define the precise mode of this action, or to say by what change of state a Cumulus already formed is thrown into this Modification. That the latter phenomenon is an Electrical effect, no one who has had opportunity to see its rapid progress during the approach of a thunder-storm can reasonably doubt.

To assert that rain is in almost every instance the result of the Electrical action of clouds upon each other, might appear to many too speculative, were we even to bring the authority of Kirwan for it, which is decidedly in favour of this idea of the process: yet it is in a great measure confirmed by observations made in various ways upon the Electrical state of clouds and of rain — not to insist on the probability that a thunder-storm is only a more sudden and sensible display of those energies which, according to the order observable in the Creation in other respects, ought to be incessantly and silently operating for general and beneficial purposes.

In the formation of the Nimbus, two circumstances claim particular attention: the spreading of the superior masses of cloud in all directions, until they become, like the Stratus, one uniform sheet; and the rapid motion and visible decrease of the Cumulus when brought under the latter. The Cirri, also, which so frequently stretch from the superior sheet upward, and resemble erected hairs, carry so much the appearance of temporary conductors of the Electricity extricated by the sudden union of its minute drops into the vastly larger ones which form the rain, that one is in a manner compelled, when viewing this phænomenon, to indulge a little in Electrical speculations. By one experiment of Cavallos, with a kite carrying three hundred and sixty feet of conducting string, in an interval between two showers, and kept up during rain, it seems that the superior clouds possessed a positive Electricity **before** the rain, which on the arrival of a large Cumulus gave place to a very strong negative, continuing as long as it was over the kite. We are not, however, warranted from this to conclude the Cumulus which brings on rain to be always negative; as the same effect might ensue from a positive Cumulus uniting with a negative Stratus. Yet the general negative state of the lower **atmosphere** during rain, and the positive indications commonly given by the true Stratus, render this the more probable opinion. It is not, however, absolutely necessary to determine this, seeing there is sufficient evidence in favour of the conclusion, that clouds formed in different parts of the atmosphere operate on each other, when brought near, occasioning their destruction by each other; an effect which can only be attributed to their possessing beforehand, or acquiring at the moment, the opposite Electricities.

It may be objected that this explanation is better suited to the case of a shower than to that of continued rain, for which it does not seem sufficient. If it should appear, nevertheless, that the supply of each kind of cloud may be kept up in proportion to the consumption, the objection will be answered. Now it is a well-known fact, that Evaporation from the surface of the earth and water returns and continues during rain, and consequently affords the lower clouds, while the upper may be recruited from vapour brought by the superior current, and continually subsiding in the form of dew; as is evident both from the turbidness of the atmosphere in rainy seasons, and from the plentiful deposition of dew in the nocturnal intervals of rain. Neither is it pretended that Electricity is any further concerned in the production of rain than as a secondary agent, which modifies the effect of the two grand predisposing causes — **a falling temperature and the influx of vapour**.

OF THE
CLIMATE OF LONDON

OF THE TEMPERATURE

TEMPERATURE is that which constitutes the most obvious difference between climate and climate, and on which the variety of the phenomena exhibited by each principally depends. I shall therefore take it up here, though standing third in the Tables, as the fittest introduction to the study of the whole subject: and as a comparison of the Results obtained by different observers, whether for the same or for different periods of years, in the same climate, tends mutually to establish or correct their respective conclusions, I shall freely avail myself of the helps I find before me in this respect.

[In putting forth this Second Edition, I have the satisfaction of being able to state, that the addition of **fourteen years' further observation of the Temperature, at one of the stations before used,** has not obliged me to displace a single Result. I shall not proceed to the refinement of fractional alterations, **founded on longer averages**, until I may be enabled to do it on entire definite periods of years; the scheme of which the reader will presently find before him. The Results of the period of seven years, ending with 1823, will, however, be found exhibited in the section allotted to periods at the end of these details. There have occurred likewise a few fractional corrections, the fruit of a careful re-examination of my calculations, by my late friend, Silvanus Bevan, jun. which are placed, with his initials to them, at the foot of the page.]

OF MEAN TEMPERATURE IN GENERAL

To mention the differing warmths of day and night, or of the different months of the year, is simply to appeal to the test of feeling. But feeling informs us on these subjects only by a vague comparison with sensations, the memory of which, when they have been some time past, is very imperfect. To confirm, or to correct our judgment, as to the comparative warmth or coldness of different days or seasons, and still more to be able to compare Climates together with accuracy, we must be accustomed to the use of the Thermometer.

If we note the degrees indicated by this Instrument when the heat of the day, by this evidence, is at the **maximum**, and again when it is at the **minimum**, and adding them together divide the sum by two, we shall have the **Medium** temperature of that day; a standard by which we may judge of the temperature of another day obtained in like manner, and pronounce it warmer or colder. This Standard would be more accurate, were the temperature noted at every hour, and the sum total divided by twenty-four. Although this process be seldom effected for the day, an analogous one is commonly performed for the Month; when taking the medium temperatures of the several days, we sum them up and divide by the number of days thus noted: the result is called the **Mean** temperature **of the month**; it is a standard for comparing the days of that month with each other. These Monthly means summed up and divided by twelve, give the **Mean of the year**: which if constructed from a sufficient number of observations, carried through all the seasons, affords a criterion for judging of the temperatures of the several months of that Year. A long average of these Yearly means, gives a result so nearly approaching to uniformity in the hands of different observers, that it may be used as a general standard of comparison for the temperature of the day, month, or year; or of the Climate in question with that of another far distant. This is called the **Mean of the climate**.

MEAN OF THE CLIMATE OF LONDON

If we regard the latitude, and elevation above the sea, of London, independently of local circumstances, the temperature has been hitherto rated too high; as was that of the city itself in the earliest observations. In the "Meteorological Journal kept at the Apartments of the Royal Society, by order of the President and Council," the period from 1778 to 1781 gives a mean of 52.65°. In 1787, this register being resumed, after a cessation of five years, we have an account of precautions now used to secure accuracy, and the ten years from 1787 to 1796 make it ……………….. 50.516°:
A similar period to 1806 inclusive …………………………………………………… 50.490°:
A third, ending with 1816 …………………………………………………………… 50.364°.

Mean of the City on the average of thirty years' observations ……………………….. 50.456°.

But the temperature of the **city** is not to be considered as that of the **climate**; it partakes too much of an artificial warmth, induced by its structure, by a crowded population, and the consumption of great quantities of fuel in fires: as will appear by what follows.

My own observations were conducted for the first three years at **Plaistow**; the site being about 3½ miles NNE of the Royal Observatory at Greenwich. The village is four miles East of the edge of London: it has the Thames a mile and a half to the South, and an open level country, for the most part well drained land, around it. The Thermometer was attached to a post set in the ground, under a Portugal laurel, and from the lowness of this tree the whole instrument was within three feet of the turf: it had the house and offices, buildings of ordinary height, to the East and North East, distant about twenty yards; but was in other respects freely exposed.

The average of all the observations at this station for 1807, 1808, 1809, is ………… 48.848°
The same for London (Phil. Trans.) ……………………………………………….. 50.608°
London warmer 1.760°.

For the next three years, the observations given in Volume II were made, partly at Plaistow, and partly at the Laboratory situate at **Stratford**, a mile and a half to the North West; on ground of nearly the same elevation. Some of these, probably, have derived an excess of warmth from the contiguity of the Instrument to a large building, in which many fires were kept: others are doubtless somewhat too low, in consequence of a change which I made in the position of the Instrument at Plaistow, and which I found to have the effect of depressing the **maximum**. The thermometer at Stratford had an open North West exposure, at six feet from the ground, close to the river Lea.

The average of these observations for 1810, 1811, and 1812, is …………………… 49.480°
That at London for the same period ……………………………………………… 50.949°
London warmer 1.469°.

Tottenham Green, where my latter observations have been made, is four miles from the North side of London, and the country to the North West especially being somewhat hilly, and more wooded, I consider it as more sheltered than the former site. The elevation of the ground is a trifle greater, and the Thermometer was also placed higher, being about ten feet from the general level of the garden before it, with a very good North exposure; but it was not quite enough detached from the house, having been fixed to the outer door-case, in a frame which gave it a little projection, and admitted the air behind it. The former Instrument having been broken, this was a different one, inclosed at first in a glass tube of an inch and a half diameter, the front of which I soon caused to be laid open, to procure a more free radiation of the heat from the Instrument within.

The average in this situation for the years 1813, 1814, 1815, and 1816 is ………………. 48.233°
And for London during the same period ………………………………………………. 49.741°

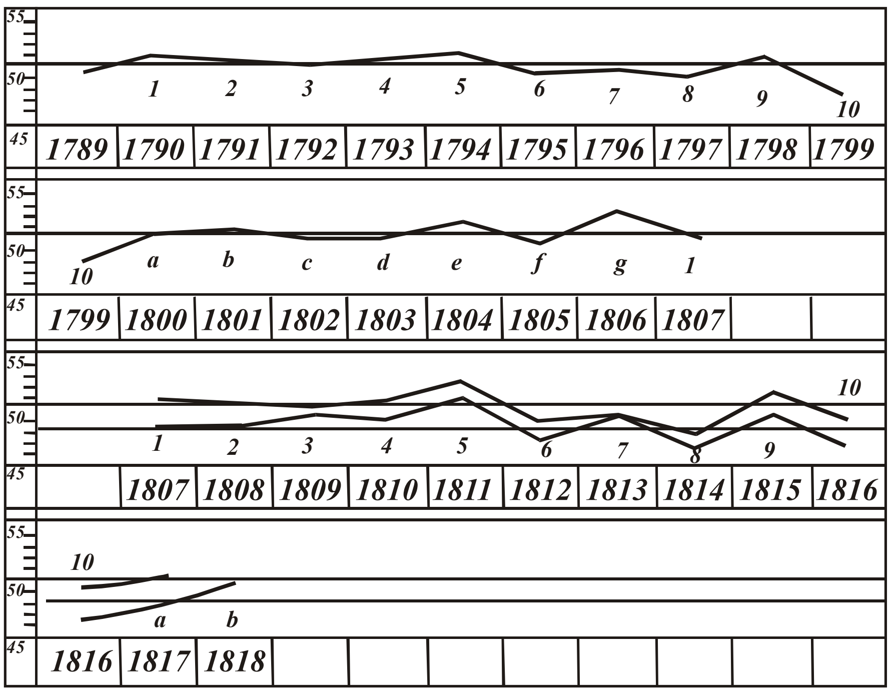
London warmer 1.508°.

Thus, under the varying circumstances of different Sites, different Instruments, and different Positions of the latter, we find London always warmer than the country, the average excess of its temperature being 1.579°. But as the same causes which produce an artificial elevation of temperature in London, must likewise influence, in a smaller degree, the country, the Mean of which for the ten years ending with 1816 is 48.79°, and as the second fractional figure was uniformly neglected in taking the Monthly means for the Annual average in the Register of the Royal Society, I shall for the present abate a little of the one, and add to the other; and for the purposes of comparison rate the **Mean of the Latitude and level** of London at 48.5°, and that of the **Metropolis itself** at 50.5°. Future observations with Thermometers previously compared, and a greater degree of care to secure the fractions, may determine these with an accuracy not as yet attained.

MEAN OF THE YEAR, AND ITS VARIATIONS

I shall have frequent occasion in the course of this Volume, to present the reader with a Series of results expressed by a curve; a mode of speaking to the eye which greatly facilitates the comparison of such variable quantities, when we wish to contemplate them only as becoming greater or less, and to view the order of their increase and decrease without reference to the exact amount of the sums compared.

FIG.1



The flexuous lines in Fig. 1 are intended to shew in this way the variation of the Annual mean Temperature of the climate of London for the series of years from 1789 to 1818 inclusive. The three upper curves are deduced from the results of the register in the Philosophical Transactions; the lower one, extending from 1807 to 1818, from the observations detailed in my first [published] Volume, with the addition of two years published in Thomson’s Annals of Philosophy, and since inserted in my second. The results having been first marked over their respective years, on a scale formed by lines ruled vertically for time and horizontally for the temperature, the curves were then prolonged from one point to the other in succession. The mean temperatures thus expressed will be found in figures in the following Table.

ANNUAL MEAN TEMPERATURE

In London	In London	In the Country
1789	49.491	
1790	50.892	
1791	50.833	
1792	50.483	
1793	50.820	
1794	51.200	
1795	49.700	
1796	50.083	
1797	49.398	
1798	50.999	
1799	47.920	
1800	50.522	
1801	51.080	
1802	50.200	
1803	50.329	
1804	51.731	
1805	49.998	
1806	52.734	
1807	50.733	48.367
1808	50.466	48.633
1809	50.633	49.546
1810	50.976	49.507
1811	52.666	51.190
1812	49.208	47.743
1813	49.741	49.762
1814	48.241	46.967
1815	51.550	49.630
1816	49.433	46.572
1817	50.316	47.834
1818	53.003	50.028
	AVERAGES	
5 years from 1790	50.845	
5 years from 1807	51.095	49.448
5 years from 1795	49.620	
5 years from 1812	49.634	48.135
10 years from 1790	50.233	
10 years from 1807	50.364	48.791
17 years from 1790	50.530	
17 years from 1800	50.600	
7 years from 1800	50.912	

EXTENT OF VARIATION OF THE MEAN.

In London in 30 years	4.814	In the Country in 12 years	4.618
Highest mean in 1806*		Highest mean in 1811	
Lowest mean in 1799		Lowest mean in 1816	

* [1818, not then out.]

The Mean temperature varies, as the reader will have seen, in different years to the extent of four degrees and eight-tenths of Fahrenheit: a quantity certainly not considerable, when we compare by sensation the warmth of one hour of the day with another; yet capable, when added or abstracted for the whole year, of producing a decided difference in the seasons. We must not, however, too hastily connect with a low Mean the idea of a cold winter, or that of a warm summer with a high one: the heat is added or taken away sometimes in one season, sometimes in another, and again occasionally almost throughout the year. But it is worthy of notice, that notwithstanding the great difference which we all find by sensation, in the warmth of the same month, week, or day in different years, (Summer and Winter on occasion almost exchanging places,) yet the total result of the seasons is so nearly uniform in each, that no one year in thirty is found by the most accurate mode of comparison to differ from another quite five degrees; and the variation from year to year is usually not half as much.

To proceed from the amount to the **manner** of the Annual variation: it is for the most part such, that the elevations and depressions take place in **alternate years**, though some of them go on for two years; and this tendency to alternation is still compatible with a disposition to rise or fall on the whole through a series of years. Thus in the space from 1794 to 1799, the mean is depressed three degrees, and from 1811 to 1816, (by my own observation,) four degrees and a half: on the other hand, there is an intermitting elevation carried on, from 1799 to 1806, by which, on the whole, four degrees and a half are gained.

Lastly, and what is more important, there is evidence, which the addition of a few more years will perhaps render conclusive, of the existence of **alternate periods of years** in the variation.

For the reader's help in comprehending this, I have numbered in the diagram the **ten** years of a period, which appears twice in the series here recorded; and have distinguished by letters the seven years of another; which having completed its course between the two periods of ten years, appears to have begun again immediately after the latter of these, and to be now in progress.

To begin with 1790, we have four years of an equable heat, upon or a little above the mean of London: the same equable average years will be found, in both the London and country observations, if we begin with 1807. Then occur six years alternating in temperature, from 1794 to 1799, the first of them the highest, the last the lowest, of the ten to which they belong: the same circumstances obtain in the six years from 1811 to 1816. Or, if we compare the averages deduced from these two sets of ten years, as given in the Table, page 4, we shall find five years from 1790=50.845, and five years from 1795=49.620; difference 1.225: again, five years from 1807=51.095, and five years from 1812 49.634; difference 1.461. That is, the latter half of each period is colder than the former by nearly the same quantity; while the two periods entire, average, within an inconsiderable fraction, alike. The period of seven years from 1800 to 1806, I have already noticed as an **ascending series**: in this, two of the elevations go on through two years. I consider it as having probably recommenced in 1817, because that year rises above 1816, and the following year, 1818, above both; as 1800 and 1801 do above 1799.

A chasm in the Register of the Royal Society immediately previous to 1787, prevents me from bringing into the parallel a series of seven years antecedent to 1799. If this series was on the whole an ascending one, it scarcely could have ended with 1789, which is stated at a degree below the average. On the other hand, it is certain from different Registers, that 1782 was as far below the average of the climate, as 1799 and 1816. The year 1787 is stated at 51.02, and 1788 at 50.63, in which depression of the mean they agree, but not in due proportion, with the corresponding years **e** and **f**, in the middle series.

On the whole, the want of observations with a self-registering Thermometer before the year 1794 throws some degree of uncertainty upon those early results: though it is probable none of them err a degree from the truth, at least if we put the artificial warmth of the city out of the question. Six's Thermometer, after having been in use at Somerset House for seventeen years, was disused towards the close of 1810 and perhaps I may not unreasonably attribute to this cause the discrepant proportions of the London curve for the following years, in one of which the temperature of the city loses its accustomed excess, and is even a small fraction below that of the country.

Should the results of the present, and four following years, to 1823 inclusive, correspond sufficiently with **c**, **d**, **e**, **f**, **g**, the inquiry respecting these alternating periods may be resumed, taking in all the evidence that can be procured from early Registers, and even carrying it into the corresponding years in the Meteorological Journals of other countries: for it is clear that the causes of such periodical changes in a climate must be Astronomical, and not local and this circumstance, if established, must lead us to expect occasional [apparent] irregularities, and as it were intercalations in the periods, which a long series of years can alone satisfactorily explain.

Of the connexion of a high or a low Mean temperature with the state of the **Barometer**, the **Rain**, and other phenomena of the year, it is too early to treat at present: it is sufficient to have shown from the manner and proportions of the variation of the Annual mean, that this variation is probably periodical; or that annual mean temperatures, nearly approaching to each other occur at intervals, consisting of definite periods of years.

MEAN OF THE MONTH, AND ITS VARIATIONS

From the variations of the mean heat during a series of years, we may proceed to its distribution among the several months of the year, and the variations of the Mean for each of them.

The general Table A, at the end of the volume, exhibits the mean Temperature of each month, in each of twenty years, ten of which, from 1797 to 1806, were taken in London, and the remainder, from 1807 to 1816, in the country.

The **averages** of these mean temperatures come out as follows.

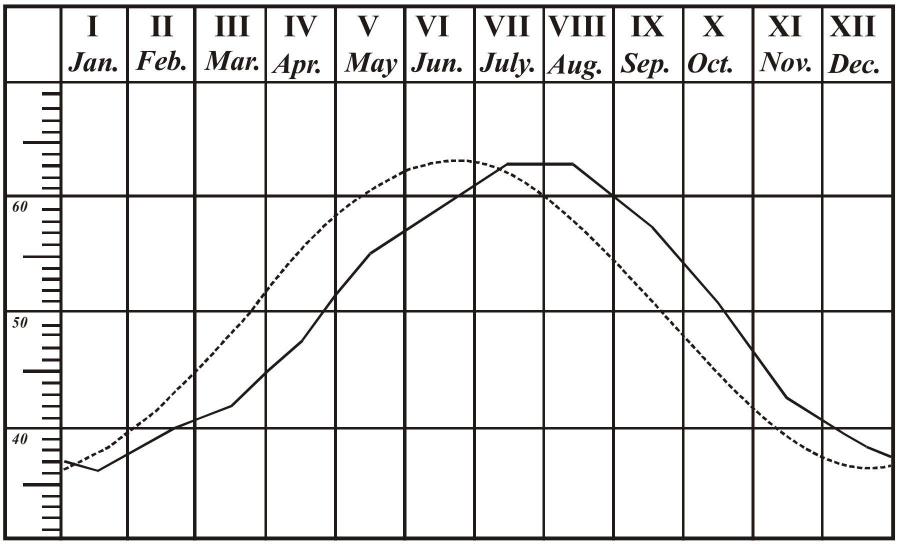
Mo.		For the City 1797-1806	For the Country 1807-1816	For the whole. 1797-1816
1	Jan.	38.52	34.16 (**e**)	36.34
2	Feb.	39.42 (**a**)	39.78 (**f**)	39.60
3	Mar.	42.51 (**b**)	41.51	42.01
4	Apr.	48.31	46.89	47.61
5	May	55.01	55.79 (**g**)	55.40
6	June	60.07	58.66	59.36
7	July	63.45	62.40 (**h**)	62.97
8	Aug.	64.41	61.35	62.90
9	Sept.	59.18 (**c**)	56.22 (**i**)	57.70
10	Oct.	51.33	50.24	50.79
11	Nov.	43.86	40.93	42.40
12	Dec.	39.76 (**d**)	37.66 (**k**)	38.71
Difference of the Extremes		25.93	28.24	26.63

(**a**) 39.40. (**b**) 42.53. (**c**) 59.21. (**d**) 39.71. (**e**) 39.76. (**f**) 41.53. (**g**) 55.74. (**h**) 62.33. (**i**) 56.15. (**k**) 37.63. - S.B.

The warmest month in the year therefore differs in its mean temperature from the coldest, **on a long average**, about twenty-six degrees and a half of Fahrenheit; and this difference is greater by nearly two degrees and a half in the country, than it is in London.

In this long average the inequalities of temperature in the same month, which constitute the principal difference of our seasons, are in great measure extinguished, the Extremes balancing each other. The series of mean Temperatures in the third column presents, therefore, a near approach to that regular gradation of heat, increasing and decreasing through the seasons, which a consideration of the primary Astronomical causes of Summer and Winter, in temperate latitudes, would lead us to expect. To make this more obvious, I have placed in Fig. 2, a curve, constructed from the series of results in question, by the side of another represented by a dotted line, which latter expresses, on a scale of the same extent as that of the **temperature**, the progress of the Sun in **declination** through the year. As I shall have occasion hereafter to enter more at large into this comparison, I shall only request the reader to notice, here, the manner in which the Monthly mean temperature, following the Sun at some distance in elevation and depression, advances from its lowest point in winter, through the spring months, to its greater elevation in summer; and then returns by an opposite gradation, through the autumnal months, to the point from which it set out.

FIG. 2.



But if, taking up the general Table A, we look for the same regular gradation in particular years, we shall meet with many exceptions, attended still with some appearance of order and compensation. For instance, in 1797, the temperature of the Second month scarcely differs from that of the First, and both are below the average of that month: the Third has the average temperature of the Second: the Sixth is two degrees deficient, while the Seventh has two in excess: a deficient temperature then again prevails, till at the close of the year we have an excess of three degrees. And in the country observations, in 1807, after an average mean in the First month, we see the Second and Third as it were exchanging places, and both cold: the Seventh, on the contrary, has a warm mean, and the Eighth a hot one; which difference in the following year is reversed in those months: then (in 1807,) we have the Ninth and Tenth almost precisely equal, while in the following year, the latter month is the colder by nearly nine degrees: lastly, 1807 goes out, as it came in, with an average mean. A careful perusal of the Table in this way, and still better the reducing of the several years to curves, on a scale similar to that on which I have placed their Mean, will give the reader an adequate conception of the manner in which the comparative coldness of one month, or season, is balanced by the warmth of another, and *vice versa*; while some years are warm and others cold, nearly throughout.

If the Monthly means in this Table be examined for the same month in successive years, down the column, it will be perceived (consistently with what has been stated respecting the Annual mean), that together with alternations in temperature, there are occasional **gradations** carried through several years, towards a warmer or a colder mean; while in a few instances, the warmest and coldest months in the series lie almost together. The greatest extent of these variations is marked at the foot of the column; and it is observable, that while the Year scarcely differs in its mean temperature **five** degrees, the month is subject to a variation which in several cases amounts to **ten**, and in one runs up to **fourteen** degrees. I very well recollect, and have verified, the extraordinary warmth of the month of December, 1806, on which the latter result depends: my own observations at Plaistow make the mean of this month 45.30, which, with a full allowance for the winter excess of the city temperature, comes nearly to the same thing. This year was the highest of an ascending series of seven, which I have marked with letters in Fig. 1. It was warm nearly throughout, and the temperature was most in excess at its close: the cause of the excess therefore was neither a local nor a transient one.

MEAN OF THE MONTH IN LONDON AND IN THE COUNTRY, WITH THEIR VARIATIONS COMPARED.

I have already stated that London has an artificial excess of heat, and shown the average amount of this excess on the whole year. In examining the Monthly means, to see whether it was alike throughout the year, or unequally distributed, I found the latter to be the case; and that attended with circumstances of considerable interest.

AVERAGE MONTHLY MEAN TEMPERATURE 1807-1816.

Mo.	In the Country.	In London.	London warmer
1 Jan.	34.16	36.20	2.04
2 Feb.	39.78	41.47	1.69 (**a**)
3 Mar.	41.51	42.77	1.26 (**b**)
4 Apr.	46.89	47.69	0.80
5 May	55.79	56.28	0.49 (**c**)
6 June	58.66	69.91	1.25
7 July	62.40	63.41	1.01 (**d**)
8 Aug.	61.35	62.61	1.26
9 Sept.	56.22	58.45*	2.13 (**e**)
10 Oct.	50.24	52.23	1.99
11 Nov.	40.93	43.08	2.15
12 Dec.	37.66	39.40	1.74 (**f**)

(**a**) 1.71. (**b**) 1.28. (**c**) 0.54. (**d**) 1.08. (**e**) 2.20. (**f**) 1.77 - S.B.

That the superior temperature of the bodies of men and animals is capable of elevating, in a small proportion, the Mean heat of a city or populous tract of country in a temperate latitude, is a proposition which will scarcely be disputed. Whoever has passed his hand over the surface of a glass hive, whether in summer or winter, will have perceived, perhaps with surprise, how much the little bodies of the collected multitude of Bees are capable of heating the place that contains them: hence, in warm weather, we see them ventilating the hive with their wings, and occasionally preferring, while unemployed, to lodge, like our citizens, about the entrance.

But the proportion of warmth which is induced in a city by the Population, must be far less considerable than that which emanates from the fires: the greater part of which are kept up for the very purpose of preventing the sensation attending the escape of heat from our bodies. A temperature equal to that of Spring is hence maintained, in the depth of Winter, in the **included** part of the atmosphere, which, as it escapes from the houses, is continually renewed: another and more considerable portion of heated air is continually poured into the common mass from the chimnies; to which, lastly, we have to add the heat diffused in all directions, from founderies, breweries, steam engines, and other manufacturing and culinary fires. The real matter of surprise, when we contemplate so many sources of heat in a city is, that the effect on the Thermometer is not more considerable.

To return to the proportions held by the excess of London, it is greater in winter than in summer, and it sinks gradually to its lowest amount as the temperature advances in the spring, [see the curves in Fig. 3,] all which is consistent with the supposition, that in winter it is principally due to the heat

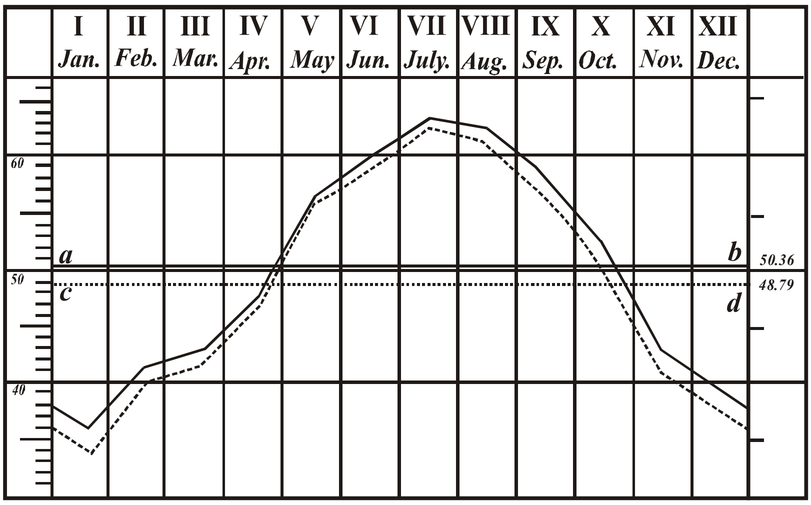
* In taking out the London results for this average, I was obliged to reject that for the month of September, 1815; many of the observations in this month being manifestly erroneous, and the mean at least 6° too high. The average of the month for the first five years exceeds that of the country by 1.77 only.

diffused by the fires. An addition of one or two degrees being of more value on a low temperature than on a high one, I replaced the numbers in the third column of the Table by the fractional parts of excess which they give upon those in the first; when they came out thus, beginning with the First month:

$$\frac{1}{17}, \frac{1}{24}, \frac{1}{33}, \frac{1}{59}, \frac{1}{114}, \frac{1}{48}, \frac{1}{62}, \frac{1}{49}, \frac{1}{26}, \frac{1}{26}, \frac{1}{20}, \frac{1}{22}$$

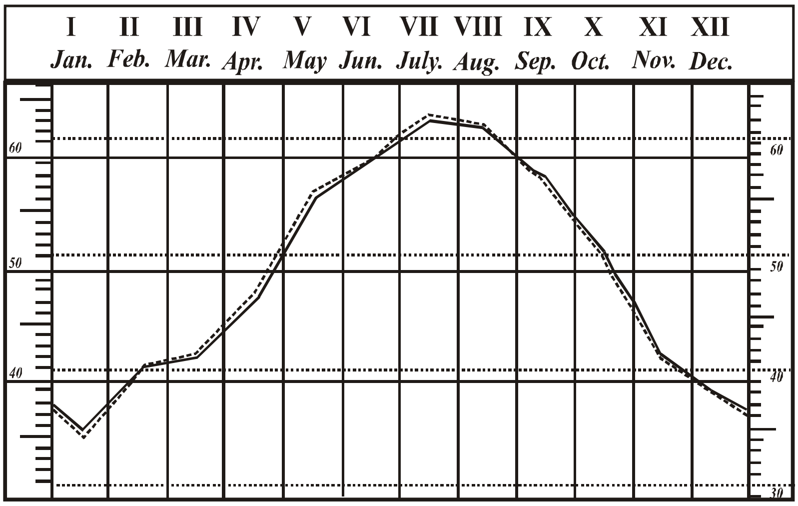
We have here a near approach to a regular gradation, the **proportion** of excess on the lower temperature decreasing from the First to the Fifth month, and then increasing again to the First. But the relations of the respective mean temperatures, with other circumstances attending them, will be best seen by means of curves.

FIG. 3.



In Fig. 3, the **full** line presents the Monthly mean of London, as given in the Table, the dotted line that of the country; the horizontal lines **a-b c-d** are on the respective annual Means; and both curves are on the same scale.

FIG. 4.



In Fig. 4, the respective curves are laid down on separate scales, and that for the country temperature, which is still a dotted line, **is elevated** 1°57, or the amount of the Mean annual difference between the two; which, as the reader will have observed, brings them very near together. I shall remark first on Fig. 3.

It appears that London does not wholly lose its superiority of temperature, by the extinction of most of the fires in Spring: on the contrary, it is resumed in a large proportion in the Sixth month, and continues through the warm season. It is probable, therefore, that the Sun in summer actually warms the air of the city more than it does that of the country around. Several causes may be supposed to contribute to this: the country presents for the most part a plain surface, which radiates freely to the sky, — the city, in great part, a collection of vertical surfaces, which reflect on each other the heat they respectively acquire: the country is freely swept by the light winds of summer, — the city, from its construction, greatly impedes their passage, except at a certain height above the buildings: the country has an almost inexhaustible store of moisture to supply its evaporation — that of the city is very speedily exhausted, even after heavy rain. When we consider that radiation to the sky, the contact of fresh breezes, and evaporation, are the three principal impediments to the daily accumulation of heat at the surface, we shall perceive that a city like London ought to be more heated by the summer sun than the country around it.

But this effect is not produced suddenly. For while, in the forenoon, a proportion of the walls are exposed to the sun, the remainder are in shade, and casting a shadow on the intervening ground. These are receiving, however, in the wider streets, the reflected rays from the walls opposed to them; which they return to the former, when visited in their turn by the sun. Hence in the narrow streets, especially those that run East and West, it is generally cooler than in the larger ones, and in the squares. Hence too, in the morning of a hot day, it is sensibly cooler in London than in the country; and in the evening sensibly warmer. For the hottest time in a city, relatively to the hour of the day, must be that, when the second set of vertical surfaces having become heated by the Western sun, the passenger is placed between two skreens, the one reflecting the heat it is receiving, the other radiating that which it has received. Many of my readers must recollect having felt the heat of a Western wall, in passing under it long after sunset.

Let us now advert to the curves in Fig. 4, in order to be convinced that the same cause operates also, on the great scale of the Year. In this figure, by elevating the lower scale, we have done away the mean difference of 1°57 in the annual temperature; or in other terms made the country as warm as London. It will now be seen that the remaining difference consists principally in this: that for six months of the year, from the Second to the Eighth, inclusive, the **country** curve holds the higher place, and for the remaining six months, the London one. This proves that, although London is always warmer than the country, **the former acquires and loses its heat more slowly than the latter**, being left behind both in the ascending and descending scale. To the same cause we may probably ascribe the remarkable fact, which appears on the average of twenty years (though not in the series of **ten** of which we have just now treated) that although the Seventh be the hottest month in the country and on the whole average, the Eighth month exceeds it in temperature, by one degree, in London.

EXTREMES OF THE CLIMATE

Before proceeding to investigate the variations of the diurnal temperature, which will conduct us through the Seasons, and complete this part of the subject, it will be proper to devote a few pages to the **Extremes** of Temperature to which the year, month, and day, are respectively subject.

The General Table B, at the end of the volume, exhibits the highest and lowest temperatures observed monthly in the country (where alone these points can be accurately ascertained) during the years from 1807 to 1816 inclusive. I have annexed to, each observation the prevalent wind or winds at the time; and in some cases, where it is considered to have equally influenced the temperature, the wind of the day preceding the observation. The **maximum** and **minimum** of the year will be readily found by the marks * and † affixed to them.

Of the extremes of **cold**, the far greater number occur in the First month, only two being in the Twelfth and one in the Second. The extremes of **heat** are more diffused: only five of them fall in the Seventh month, and the remainder in diminishing proportion earlier and later in the summer. Thus of the whole twelve, there are only two months in spring and two in autumn, which are not occasionally subject to one or the other annual extreme of Temperature.

The Thermometer stood in the year

			Range	Medium
1807	at 87°	and 13°	74	50
1808	96	12	84	54
1809	82	18	64	50
1810	85	10	75	47.5
1811	88	14	74	51
1812	78	18	60	48
1813	85	19	66	52
1814	91	8	83	49.5
1815	80	17	63	48.5
1816	81	-5	86	38
Averages	85.3	12.4	72.9	48.5

[The observations made since, to the year 1831 inclusive, do not present a greater range of Temperature than is here stated. The result of these will be found further on.]

I have before stated the mean Temperature of the country, on the average of all the **daily** extremes, or which amounts to the same thing, of the medium of each day, during the above ten years, at 48°79. On the average of all the **monthly** extremes in Table B it is 48°34: and on that of all the **yearly** extremes, as given above 48°85. Even the greatest heat and greatest cold, in these ten years, diverge to nearly equal distances from the Mean of the climate.

This agreement in the different averages is certainly remarkable: it gives further probability to the opinion, that these years form a series:- it is likewise a striking proof of the utility of a self-registering Thermometer. It is possible, that in the Thermometer of Six we possess an instrument, which being merely fixed to a post, and properly defended from the sun's rays and from accidents, in an uninhabited country, where it could be visited and adjusted by navigators once in every year, would give, in a moderate run of years, with considerable accuracy, the Mean temperature of the latitude and elevation where it stood. In like manner might an accurate comparison be made with little labour, at the summit and at the foot of mountains, of the Mean temperature of the several months at different elevations. When Meteorology shall have become a science, and be studied by navigators, travellers, and men of competent skill engaged in local surveys, experiments of this kind will perhaps be as common as the taking of levels and angles, and observing the motions of the heavenly bodies, for the perfecting of Geography and Astronomy.

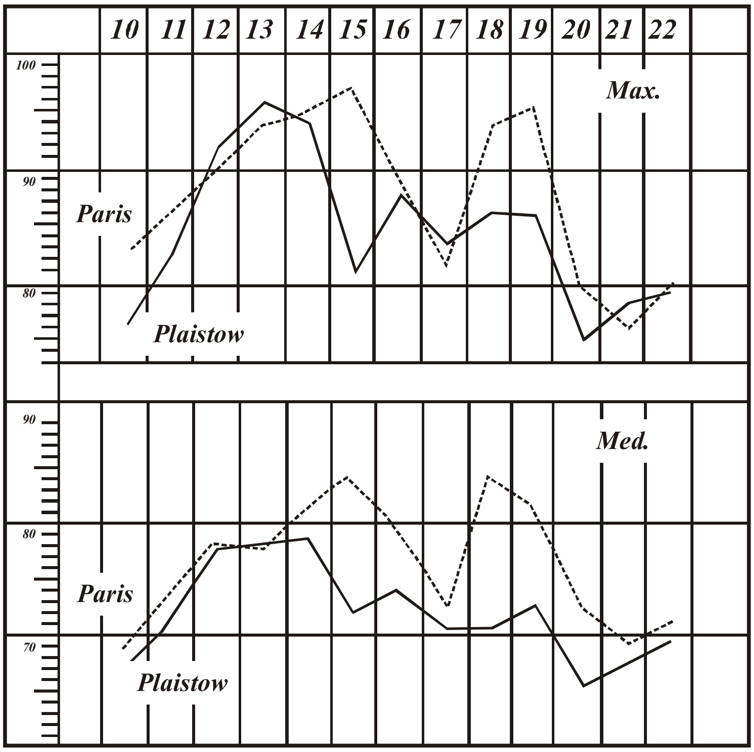
To return to the Extremes of our own climate for the last ten years — the day of **greatest heat** within my observation was the 13th of the Seventh month, 1808, when I was attentive for many hours to the phenomena; of these the reader will find notes, (which would have been more copious had I been aware at that time of their importance) under Table XXI in the Vol. II. To prove the extensive action of the combined causes of this excessive heat, I shall here compare, by means of the curves in Fig. 5, the maximum and medium temperature at Plaistow with that at **Paris** (distant 180 miles to SSE) for the space of thirteen days, in which the principal elevation of temperature took place.

The maximum at Paris on the 10th of Seventh month (see the Notes above mentioned) was 82°6, the wind NW: that at Plaistow on the same day was 76°, the wind SW. During the three following days, the heat at each station increased steadily, the wind at Paris being E and SE, and at London S and SW. On the 13th, when the thermometer with us had risen to 96°, the evening atmosphere presented **dew** to the SE, and some traces of **thunder-clouds** to the NW: the change then was approaching from the latter point, while the atmosphere of Paris remained as yet undisturbed: its heat was below ours, being only 93°8, and it did not reach its climax till the 15th, when the thermometer there rose to 97°2, and fell only to 70° at night, the wind SE. In the mean time distant thunder-storms to the Westward, and one in particular about Gloucester, of a character for intensity suited to the exaltation of the predisposing causes, reduced **our** maximum in two days to 81°, with the wind at NE. In two days more the change thus propagated from the Westward appears to have reached Paris; **they** were cooled down on the 17th, to 81°5 by day and 62°7 by night. Immediately after this, a second elevation of temperature took place with them, which was felt also in a less degree at London, on the 18th and 19th: lastly, the heat at both places went down to the ordinary summer standard, by a SW wind introducing rain.

The mean heat of this period of thirteen days at Paris was, by day 87°69, by night 63°92, on the whole 75°80: the mean at London (Plaistow) was by day 84°38, by night 58°77, on the whole 71°57. Thus Paris had, on the whole (consistently with its more Southern latitude) about 4¼ degrees more heat than London; yet with variations throughout strikingly analogous to our own: till on the 22d, with the same winds in play at each station, the temperatures of the two became nearly equal: in which situation, although the comparison might have been further prosecuted, we may leave them.

This heat was not with us of the sultry oppressive kind which commonly ushers in a thunder-storm: the sky was serene, and a fine breeze prevailed; yet such was the ardour of the sky, that motion was unpleasant, and labour in the sun dangerous: the feathered tribes were mute by day, and revived by the freshness of the night, were heard singing by moonlight. In the evenings the dew fell pretty freely, and at temperatures which in ordinary circumstances would have sufficed instantly to dissipate it; but the production of this phenomenon depends, at all times, not on the absolute but on the **relative** temperature of the calm evening air after a warm day: and if this be cooled 20° or 25°, it matters not whether it were previously charged with water at 55° or 95° [dew will certainly fall] provided the refrigeration pass that degree at which the whole quantity can no longer subsist as vapour.

FIG. 5.
Seventh Month, July, 1808.



I had equal opportunity of observing at Tottenham the **intense cold** of the 9-10th of Second month, 1816, respecting which I need not enlarge here, having given already a pretty long note on the subject, under Table CXV [Vol. II]. We had on this occasion likewise, in the day time, a clear atmosphere: a gale from the NE had precipitated in snow the moisture which previously abounded; and which had twice in the space of a few days brought the Hygrometer to 100°. So cold was the surface on the 9th at noon, that a bright Sun, contrary to its usual effect in our climate, produced not the least moisture in the snow; the polished plates of which retaining their form, refracted the rays with all the brilliancy of dew drops: the Thermometer in these circumstances rose only to 20°, or **seventy-six degrees** below the temperature of the middle of the hot day I have described: in the night it went down (in its usual position) to minus 5; and there is every reason to believe that the mass of our atmosphere was on this occasion at a temperature below **zero** for about twelve hours. This is a state of the air not uncommon, I believe, for several days together, on the continent in higher latitudes; but with us it is happily, of necessity, very rare and transient.

A comparison of the observations at Tottenham with those at Paris, will again furnish some curious coincidences. I shall present the **minimum** and **medium** of each in curves, and insert here the temperature at Paris reduced to Fahrenheit's scale, from the observations of **Bouvard** in the Journal de Physique: my own as to the daily extremes, will be found in their place in the Second volume: the daily **medium** I shall annex here.

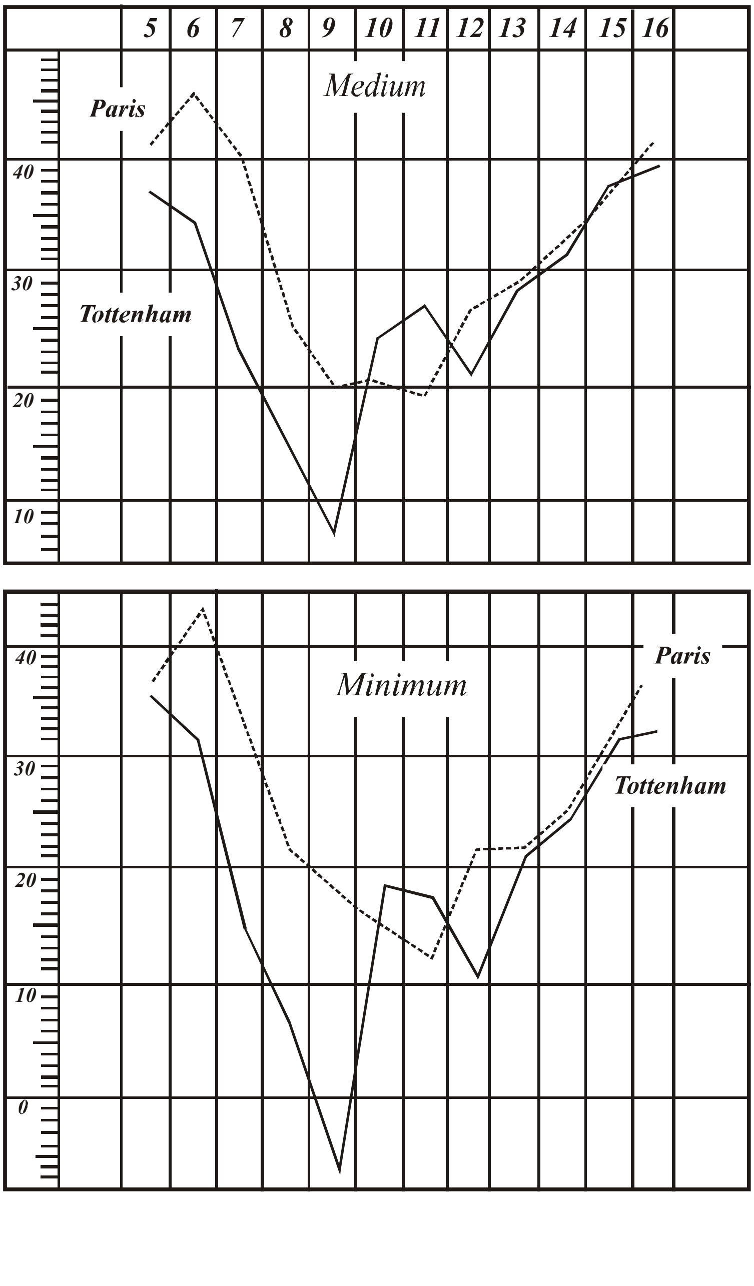
The Mean temperatures at the two places for the period occupied by these observations, appear to bear very nearly the same proportion to each other as in the former series; Paris being 4°67 warmer than London.

1816	At Paris Max.	Min.	Med.	Wind	At Tottenham. Med.	Wind.
Second Mo. 5	45.68	36.50	41.09	W	37.00	S
6	48.65	43.25	45.95	SW	34 50	SE
7	48.65	32.45	40.55	SW	23.00	NE
8	30.20	21.65	25.92	NE	15.50	N
9	22.10	18.25	20.17	NE	7.50	E
10	26.15	15.35	20.75	ENE	24.50	SW
11	27.05	12.65	19.85	E	27.50	N
12	35.60	22.55	29.07	NE	21.50	N
13	36.50	22.55	29.52	NE	29.00	Var.
14	41.00	26.15	33.57	N	32.00	W
15	41.45	33.65	37.55	WNW	38.00	SW
16	44.60	39.65	42.12	W	40.00	NE
Mean of 12 Days.			32.17		27.50	

A slight **elevation** of the nocturnal temperature on the 6th at Tottenham, was followed by a corresponding but more considerable one, at Paris on the 6th: it was misty with some rain at both. On the evening of the 6th, the rain with us, by the change of the wind, became sleet, and finally snow, which fell in the night in great quantity, and at intervals in the day after; while there was still only rain at Paris. The North-Easter did not set in there until the 8th, and the depression of temperature, with the snow, was late in proportion. This depression, which on the first days proceeded as rapidly with them as with us, appears to have experienced a check, at the time when our own temperature was at the lowest; and we find the **extreme** of cold at Paris **two** days later than at London: it is moreover not by any means proportionate to the difference in the mean temperature of the two places, reaching only down to about 13°.

In the subsequent **rise** of the Thermometer we see Paris take the lead of London, contrary to the order in the beginning of the series: there is a second depression also in the Tottenham curve, from a cause which is felt more slightly and somewhat later at Paris. Lastly, when the frost is actually going off, and a Westerly wind makes its appearance at both stations, we see the elevation of temperature at each go on together.

FIG. 6.
Second Month, February, 1816.



PROBABLE CONDITIONS OF EACH EXTREME OF TEMPERATURE.

Let us now review the case of each Extreme of temperature in our climate, and see what conditions appear necessary to its production: and first of the **Extreme of heat**.

To produce the highest possible temperature in our climate, there appears to be required,

First, a **clear atmosphere** at the time: that the sun's rays may have the freest possible access to the earth's surface.

Secondly, a **dry** and **warm** state of the **soil**, to some considerable depth: that the earth may reverberate freely, without throwing up such a quantity of vapour as by its speedy condensation, in the higher and colder regions of the atmosphere, might produce cloudiness and annul the first condition.

Thirdly, these two causes must concur at a season when the sun is not far from its greatest elevation: otherwise the heat will be in excess, only relatively to the time of year at which it occurs.

Fourth and lastly, to carry the heat to the very highest point, we must receive, at this crisis, by means of steady southerly breezes, the air of the Southern parts of Europe; while these in their turn are supplied from Africa, and the South of Asia. A wind of this kind, which would travel from Paris to London in a day, would reach us in a week from the tropic of Cancer.

To produce the **lowest possible temperature** in our climate there is required,

First, as in the former case, a clear and dry atmosphere at the time, that the heat may freely escape by radiation: this condition will be best appreciated by those who have read the experiments of Dr. Wells, on the subject of the radiation of heat from the earth's surface.

Secondly, a cold state of the soil, (the usual result of previous cloudy, wet, and frosty weather,) and this to some considerable depth: that the sun's rays may not be assisted by any warmth from beneath, in raising the Temperature by day.

Thirdly, the concurrence of these two causes with a sufficiently low state of the Sun, and consequent length of night: otherwise the cold, although severe for the season, will not be such as to be remarkable in comparing together the results of a series of years.

Fourthly, a cause must concur, which but for the parallel that I wished to exhibit, between certain conditions common to the two cases, I should have placed first — the winds must come to us from the Northward; when, if they blow with sufficient steadiness, we may receive them at length from Siberia.

When this state of the wind supervenes upon our mild winter weather, it speedily gives us a serene atmosphere: our **moisture** is first precipitated on the meeting of the two currents, in an abundant snow; the latent heat of the vapour being given out to the air, which passes with it to leeward. The air which succeeds, coming from a still colder region, and being intensely **dry**, our own ice and snow evaporate into it; and there is thus, towards the close, a contrary effect — an absorption of heat, which undoubtedly contributes to carry the depression to its extreme point.

It may seem extraordinary, in the case I have just reviewed, that at such a distance from the Winter solstice, the power of the sun should not have prevented, in a greater degree, the effect of the Northerly current. But we have here, probably, an effect similar to that which takes place in a single night of frost: the Temperature (as is well known) is then often lowest just before sun-rise, the nocturnal depression, (an effect of the sun's absence,) continuing to go on until the approach of his rays becomes again sensible: so in the present case, the long time during which the sun had been low may be admitted among the predisposing causes of the extreme depression — which, in all probability, would not have been produced by the concurrence of the other causes, at an equal interval **before** the solstice. I find that the depression in 1796 to -6.5 which I mentioned in the note Tab. CXV as analogous to the present, occurred in the night between the 24th and 25th of December,[*] just after the winter solstice: it was preceded by a heavy snow on the 23d, and a clear day on the 24th, with the temperature at 23° at noon.

Such are the causes, the concurrence of which appears requisite for the production of the Extremes of temperature in our climate: and they will probably be found to concur in most of the

[*] Extracts from a Meteorological Journal kept at Edmonton, Middlesex. By John Adams, 1814.

cases of great heat and excessive cold recorded in our Registers. The history of the means by which the Equilibrium is restored, and the temperature made to approximate again to the ordinary state of the season, is more simple. It appears to be effected, **in both cases**, by an irruption on land of the more temperate air of the Atlantic. In effect, a SW wind was no sooner established, than the heat in one case, and the frost in the other, gave place to its influence.

By admitting this re-action of the Atlantic atmosphere, we are able to solve the problem of the maximum of temperature, in one case, and the minimum in the other, falling two days **later** at Paris than at London; in consequence of which, on a given of the cold season, it was colder by several degrees at Paris than at London, and on, another in the hot season, warmer at London than at Paris: for the latter city, lying more remote from the Atlantic than London, and in the midst of a larger mass of atmosphere, resting on a continent, and more difficult to displace than our, insular air, was in consequence later in receiving the change: and the causes, whether of elevation or depression of temperature, continued to operate during the interval.

To conclude, it will appear on examining the Table B throughout, that our warm weather **in winter** has almost uniformly come from the SW, the S, and W: but **in spring and summer** as frequently from the S and E: and that with regard to the cold extremes, a large proportion of them are connected with a NW wind, which in some instances is set down NW a N, (North-west after North). The reason of this connexion may be, that after the wind has been for some time North East or North, it has shifted to the NW just before the change to the Southward — when (from a cause before explained) the cold, by continuance, arrives at its greatest intensity for the time.

EXTREMES OF DAY AND NIGHT

The difference between the temperatures of day and night, or between the higher and lower Extreme of the twenty-four hours, is subject to great variation. Sometimes, from the effect of a steady wind with cloudy weather, or slight frosts with snow, the temperature will scarcely vary five degrees in twenty-four hours: at others, a clear night succeeding to a day of much sunshine, or the sudden going off of severe frost by a change of wind, shall cause a variation in either direction, of twenty, thirty, or more degrees. The reader will find many examples of these changes, in examining the periods about the middle of winter and beginning of summer. To give a few instances: Tab. LXXXVIII Dec. 4-9; six days with a uniform maximum of 44°, and the nights mostly but three or four degrees colder: Tab. XL and XLI many days in First month very uniform: Tab. XXI three days at: 92°, 96°, 94°, and the nights at 63°, 60°, 63°, respectively: Tab. CXLIV several nights, in the fore part of the Sixth month, in which the thermometer was lower, from 35° to 37°, than in the day: Tab. CXVI Second month, 9-10, a rise from -5° to 30°: Tab: CXXXVI Tenth month, 29-30, a rise from 27° to 57°: again, Tab. CXXXI Fifth month, 15-17, the nights at 33°, the days at 65° and 67°.

EXTREMES OF DAY AND NIGHT IN LONDON AND IN THE COUNTRY.

But it is by mean results in this, as in several previous cases, that we arrive at the clearest view of the subject. In the two Tables, [C1, C2, at the end] I have given under the titles **Higher mean**, and **Lower mean**, the monthly averages of the daily **maxima** and **minima** of the thermometer for twenty years: ten of them in London, and the following ten in the country. A mean of these numbers being taken for each month, on each set separately, the following results are afforded.

The higher mean, or **heat of the day**, taken on the observations from 1797 to 1806, **in London**, is 56°17: the lower mean, or **cold of the night**, on the same, 44°80.

The higher mean **in the Country**, taken on the observations from 1807 to 1816, is 56°51; the lower, 41°10.

The mean variation of temperature, from the heat of the day to the cold of the night, is therefore

In London	11°37
In the Country	15°40
Greater mean variation in the country	4°04

The close coincidence in the averages of the **heat by day**, in London and in the Country, for two different decades of years, is certainly remarkable. I am prevented from forming an accurate comparison **on the same set** of years in either case, by the want of a complete series of observations with Six's Thermometer; without which it is useless to attempt a parallel of the **Extremes** of temperature.

Now, as to the **nights**, 44.80-41.10=3.70: and we found before an excess for London, **on the mean of twenty-four hours**, of 1.47, which doubled (as it was halved by taking the medium) is 2.94. This difference in the average of the nocturnal Extreme, exceeding the difference on the total average of mean temperatures, makes it probable that the excess of London, however acquired, is retained in such a way as to operate chiefly on the lower observation, entering but in a small proportion into the **Maximum**. And, in effect, the averages at the bottom of the columns in the **Lower mean** table, show that the nights in London are at all times so much warmer than in the country, as that no difference of seasons in ten years is able to reduce them below the latter in the average. Whereas, in the **Higher mean**, from the cause just mentioned, the monthly average of London is sometimes above, sometimes below, at others nearly parallel with the country one.

EXTREMES OF DAY AND NIGHT IN THE SEVERAL MONTHS OF THE YEAR.

It is natural to expect that the difference between the temperatures of day and night should increase, in proportion as the Sun acquires more power by elevation; or that it should be greater in summer than in winter. The following Table, drawn from the two general ones to which I have just now referred, will show to what extent, and in what proportions, this difference proceeds through the Seasons. In constructing it, I have preferred the long average, which includes ten years in London: and have obviated the effect of the local warmth of the city, by deducting its excess, not from the mean of twenty-four hours, but (on the ground of the preceding examination) from the **lower** mean exclusively. Thus, the average of the lower mean on ten years in London being for the first month 35.44; that of the higher mean 41.61; and the two for the country, respectively, 29.33 and 38.96, the calculation for this month runs as follows:

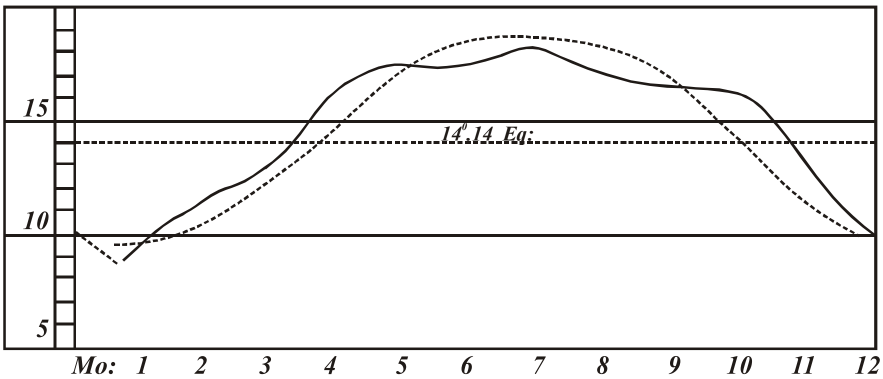
35.44 - 2.04 (see page 8) = 33.40
33.40 + 29.33 = 62.73 ÷ 2 = 31.365
41.61 + 38.96 = 80.57 ÷ 2 = 40.285
40.285- 31.365 = 8.920,

the difference between the higher and lower mean of the month on twenty years: and so for the remaining months.

Mo.	Mean of greatest heat by Day.	Mean of greatest cold by Night	Difference
1 Jan.	40.285	31.365	8.920
2 Feb.	44.635	33.700	10.935
3 Mar.	48.085	35.315	12.770
4 April	55.375	39.420	15.955
5 May	64.065	46.540	17.525
6 June	68.360	49.750	18.610
7 July	71.500	53.840	17.660
8 Aug.	71.235	53.940	17.295
9 Sept.	65.665	48.675	16.990
10 Oct.	57.060	43.515	13.545
11 Nov.	47.225	36.495	10.730
12 Dec.	42.660	33.900	8.760
Averages	56.345	42.204	14.141

The third column presents, we must remember, a series of differences between the average extreme temperatures of day and night, divested, by compensation, of the disturbing effects of different winds, of cloudy or clear days, of the presence or absence of rain or snow, and of the variable pressure of the atmosphere.

FIG. 6.*



We find accordingly in these numbers a gradation which agrees well with that of the Sun's declination, reduced to half scale. [See the Fig. also Fig. 2.] The greatest difference is found in that month in which the Sun is highest, and longest above the horizon; the least, in that in which he is least elevated, and makes the shortest stay with us. But there are other circumstances, not so obvious, connected with the proportions of these numbers, which we are not yet prepared to discuss. It may suffice, therefore, to consider them for the present, as **an approximation** to a series, representing, in degrees of Fahrenheit's thermometer, the mean quantity of heat, actually produced by the direct and reflex action of the Sun's rays, in each month of the year.

DIURNAL MEAN:
VARIATION OF THE DAILY HEAT THROUGH THE SEASONS

Perceiving, very soon after I had begun to investigate the Temperature, the necessity of a fixed standard, with which to compare the very considerable variations in the mean heat of the same day, in different years, I determined on constructing a set of Tables applicable to this purpose. I then possessed Observations on the Thermometer in the country for ten years: and as it was certain that the temperature of the Year did not reach both extremes of its variation in so short a period, it was needful to take into the average the ten preceding years from the Register of the Royal Society. The method employed for forming these Tables was, to set down the higher and lower observation of each day, under the day, through the month; then to repeat the operation for the same month in the next year; and so on for ten years. The average of the sums in each **column** gave the mean heat of the **day** for ten years, and that of each **line** in the table, the higher and lower mean alternately for the **month**. The **monthly means for ten years** being then deduced, both from the final column and from the line of averages at bottom, the agreement of these, within certain limits, was considered as proving sufficiently the correctness of the calculation. A similar set of averages being likewise deduced from the country observations, the medium betwixt the two was taken for a general standard of the diurnal and monthly temperature. See the General Tables, D, 1, 2, 3.

The circle of Temperature for the year being thus obtained in figures, I became curious to see how it would appear in a diagram, and what relation it would bear to a circle, placed within a scale of the same extent, and representing the Sun's progress in **declination** through the year. This inquiry (not to trouble the reader with an account of its progress) terminated in the construction of the Scheme of temperature and declination, contained in the two copies of Plate 1, facing the Title-page, which I shall now proceed to describe. The reader will first avail himself of the copy least coloured; as we have to do at present only with the lines and figures.

The Diagram, as the reader will have perceived at once, presents a circular scale for the year, divided (except where the termination of the months required a difference) into intervals of five days. Each of the lines forming these divisions forms likewise a Scale of temperature; being cut at equal intervals by the concentric circles, which are distant from each other five degrees of Fahrenheit; the **highest** part of the scale being **within**, or towards the centre, the **lowest, without**, or towards the circumference. Just without the circle representing 50°, is another formed by a heavy solid line: this is placed on the **Mean of the climate**; and with reference to the declination, it represents also the **Equinoctial or Equator**. The circle representing the Sun's declination through the year, would be readily found by its being so greatly eccentric: it is, however, further marked by the word **Ecliptic**, and by the signs of the Zodiac, with degrees of declination marked at intervals. The North declination is made to proceed towards the inner or upper part of the scale of Temperature, the South towards the outer part, or bottom; the extreme distance from the Equinoctial each way, (or 23°28',) being equal to 15° of the Thermometer.

Having thus far explained the figure, I must now request the reader's attention to the circle formed by a flexuous line, which traverses the scale through the Year, and presents the same eccentric appearance as the circle of declination. This is the curve of the daily mean Temperature prolonged through points marked for each day on the scale. On a general view, the reader will perceive that, like the circle of declination, it is highest in Summer and lowest in Winter, and that it crosses the mean line twice, in Spring and again in Autumn: but not at the same time with the declination, being about a month later. If we trace the correspondence of the two circles, we shall find this difference in time to obtain throughout the year.

At the Autumnal Equinox, on the 23d of September, (to omit for a while the numerical designations of the months,) the Sun being in **Libra**, we have the diurnal Mean temperature at 55°, or six degrees above the Mean of the year; to which it does not attain in its gradual descent, until the 22-23 October, when the Sun advancing in South declination, has nearly reached the first degree of **Scorpio**.

Proceeding through the next two signs to the Winter Solstice, the declination, keeping in advance of the Temperature, arrives at its South extreme on the 22d of December, the Sun in **Capricorn**: but the Temperature does not reach its lowest point (at 31°45) until the 12th of the following month. And as the declination varies but little for a considerable space about the Winter Solstice, so we have here a sameness in the line of Temperature, which after a small elevation, almost revisits the cold extreme on the 25th January. The lowest Temperature of the year may therefore be said to occur, about the time when the Sun enters **Aquarius**. During this time, the declination having proceeded Northward a few degrees, the two circles coincide, and for a considerable space, the variable curve of the Temperature intersects, at intervals, the regular one of declination. As the season proceeds, the latter takes the lead in rising, the divergence of the two lines increasing up to the Vernal Equinox, 21st March, the Sun in **Aries**; thirty days after which, at his entrance into **Taurus**, the Temperature is about to touch the mean of the year, which it crosses on the 24-26th April. The ascending Temperature now follows the declination, keeping the same distance as before, to the Summer solstice, (22d June, the Sun in **Cancer**,) but the Temperature at this time is at 58°85, or six degrees short of its higher extreme. When the Sun, having passed his greatest elevation, has declined a little towards the South, the two circles coincide as before, and with the same solstitial character (if I may so use the term,) in the curve of Temperature; which continues here for a longer time about the same level; insomuch that the local excess of London causes the hottest **days** to appear in the beginning of August; whereas in the country they are the 12th and 25th of July; which, with greater consistency, places the hottest season in the space between those days, or about the Sun's entrance into **Leo**.

From this time the declination falls in the scale, keeping in advance of the temperature and the divergence of the two from each other increasing (as before in Spring,) down to the Autumnal Equinox: from which point, it will be recollected, we set out in the comparison.

Thus, the average of each day upon the observations of twenty years, though made under the disadvantage of a local cause, irregularly raising the Temperature in one half of them, has furnished a practical proof of that which was before admitted in theory, that **the diurnal Temperature**, abating the influence of temporary causes of variation, **is determined by the Sun's altitude at noon throughout the year**.

The curve of the Mean temperature, we may observe, scarcely ever rises or falls uniformly for a week together; but is continually interrupted by deviations. Yet the general effect so nearly agrees with the progress of the Sun, that, were the circle of declination shifted, and its centre made to coincide with that of the curve of Temperature, the latter would cross the former in more than fifty places, besides a great many in which they would be in contact. Setting aside the effect of the local excess of London, these deviations appear to be the result of the different Winds, which prevail at the same season in different years, producing very considerable elevations and depressions of Temperature, which however do not perfectly balance each other in the average of twenty years chosen for my Tables. I suppose that a very long average, or one taken from a real natural period of years, and in which local influence on the Thermometer should be avoided or allowed for, would bring out a curve much more nearly resembling the circle of declination. And it is now proper to observe that the latter is not a true circle. For, there being seven days more on the Summer than on the Winter side, a true circle would not have intersected the Equator at the Equinoxes, while it departed to an equal distance from it at either Solstice. It is therefore somewhat oblate or partaking of the form of a circle of larger diameter, in the Summer months: and there is every reason to conclude, that the true theoretical curve of the diurnal Mean temperature, will in the end be found to have the same disproportion between the half of the circle above, and that below, the **Mean** of the year.

NATURAL COMMENCEMENT AND DURATION OF THE FOUR SEASONS.

The fact of the Mean and Extreme temperatures occurring with so regular a relation to the Equinoxes and Solstices, yet at so considerable a distance after them, has suggested to me a new and more natural demarcation of the limits of the Seasons of our Climate: which I have now, with the help of the second or **coloured** plate, to lay before the reader.

It is clear that in these Latitudes we have four seasons, distinguishable by the rest and progress of nature in the vegetable world. We have a germinating leafing **Spring**, a flowering **Summer**, a fruit-bearing **Autumn**, a dormant naked **Winter**. Now, the difference of these from each other depending chiefly on the Temperature, as to its elevation and the direction in which it is proceeding, in the parts of the year in which they severally take place, if we can divide the Yearly circle of the varying heat in such a way as shall at once make its four parts symmetrical, and bring them more nearly to accord in time with the natural appearances above mentioned, a departure from the customary divisions of the 'Quarters' will, by the Natural philosopher, at least, be cheerfully tolerated.

Let us then remove the beginning of the seasons **fifteen days** in each case from their respective present situations, placing them at that distance **before** the Equinoxes and Solstices.

SPRING will then begin the 6th of the Third month, **March**, at the temperature of 39°94[*] (see the Table,) it will occupy 93 days, and will end on the 6th of the Sixth Month, June; at 58°08 — the temperature having risen 18°14[†] degrees.

SUMMER will begin on the 7th of **June**, and it will last 93 days; during which space the mean temperature will have risen from 58°08 to 64°75† or 6°67; and have declined again 6°59: it will end on the 7th of the Ninth month, **September**.

AUTUMN, beginning on the 8th of September, at 58° 16, will have 90 days: during which, the mean temperature will have declined 18.35‡ degrees, and it will close on the 6th of the Twelfth month, **December**, at 39°81.

WINTER, comprehending 89 days (or in leap years 90) will begin December the 7th. During this season the mean diurnal temperature having fallen 5°36[§] to 34°45, will have risen again 5°49 or to 39°94, on the 5th of the Third month, **March**, the concluding day of the season.

To make the symmetry and proportions of the Seasons, as thus distributed, more obvious to the sense, the second plate has been coloured thus:- the space between the line of the Annual mean and that part of the variable curve of daily Temperature which lies **above** it in the scale, is made **red**: this space may be considered as representing the **heat** of the year. The space betwixt the mean line, and the curve of the daily Temperature lying **below** it, is coloured **blue**, and may be considered as representing the **cold** of the year. The remainder of the ground of the scale being filled up with four colours, appropriate to the Seasons, they are thus marked out from each other like the countries in a map. The Summer is seen at once to contain the largest portion of the sensible heat of the year; which after increasing to the middle of that season, decreases again in the beginning of Autumn. In this season, the **heat** gradually goes out, and is succeeded in the middle by sensible cold, which becomes considerable by the end. Winter exhibits as large a proportion of the cold as Summer did of the heat, and with the like increase and decrease. In Spring, we see the cold gradually go off, to be replaced in the middle of the season by warmth; their respective proportions being like those which obtain in Autumn, while their positions are reversed. Lastly, by the beginning of Summer (with which we set out) we see the heat increased to a degree sufficient again to constitute that season.

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[*] The initial and terminal temperature of the season is taken, in every case, at a **medium** between the day on which the one season ends, and that on which the other begins: thus 39.67 + 40.22 + 2 = 39.945: and so of the rest. [39°96 - S B.]

[†] 18.12.- S B.

†64.95, 6.17, 6.79.- S B.

‡18.20, 39.90.- SB.

[§] 5.51, 5.51, 39.96.- SB.

CAUSE OF THE DIFFERENCE BETWEEN THE ASTRONOMICAL AND THE REAL SUM OF HEAT; OR BETWEEN THE SUN'S DECLINATION AND THE TEMPERATURE.

It remains for me to show why the Temperature, both in its increase and decrease, is always a month behind the Sun.

The heat existing from day to day in the portion of our atmosphere next the Earth, is at no time the simple product of the direct action of the Sun's rays on that portion. It has been found by experiments carefully conducted, and continued for a great length of time, that the direct action of the Sun's rays, in a calm air, will raise the Thermometer an equal number of degrees, whether the time be the Summer or the Winter solstice, whether the temperature be at summer heat or near the freezing point.* It is therefore probable that the mass of the air is similarly affected, and that the proportion of heat which it derives from the direct passage of the rays is alike in all seasons. The accumulation of heat near the surface of the Earth, which we always experience from continued sunshine, is evidently due to the stopping of the rays at that surface; to their multiplied reflections and refractions, in consequence of which the light is as it were absorbed and fixed, for a time, in the soil and in the incumbent atmosphere. By this process the Earth, when in a cold state at the end of Winter, **becomes gradually heated to a certain depth** as the warm season advances. On the other hand, when the Sun declines in Autumn, the soil thus heated acts as a warm body on the atmosphere, and **gives out again the heat it has received**.

The Thermometer is therefore placed betwixt the Sun and a reflector, the Earth; and the heat which it indicates is at all times the product of the compound action of the two bodies. Now, if I place a flat skreen suddenly before a clear fire, I shall not need a Thermometer to learn, that at the first moment the skreen reflects no heat into the space between them it requires first to be heated itself, that is to say, the rays which first fall on it are for the most part absorbed; but as soon as heated, it reflects copiously. It is thus with the Earth's surface: it is a skreen behind the Thermometer, which absorbs heat during the Spring, and gives it out again in Autumn.

Were it not for this effect on the part of the Earth, the heat indicated by the Thermometer would probably on a long average (to obviate the remaining irregularities, caused by clouds, rain, wind, and evaporation) be precisely at its **maximum** and **minimum** at the Solstices, and at the **mean** at the Equinoxes. For the power of the Sun is proportionate to the quantity of parallel rays falling on a given area of the Earth's surface. And this quantity is greatest when they are vertical, and diminishes as they become more oblique; till in a perfectly horizontal position of the rays it is null. On this principle depends the superiority in heat, of noon over morning or evening, of our summer over our winter, and of the Tropical over the Polar regions. As the Sun advances in North declination, therefore, the heat we derive from him increases, actually in proportion to his altitude, but not sensibly; because a part of it is required to heat the Earth, and is lost there by absorption. As he declines Southward in the Autumn, the heat we receive actually grows less in proportion, but not sensibly; because we now receive back a certain quantity from the warm Earth. And it would appear that, were the Earth's surface at a mean temperature, and were the Sun's rays suddenly and totally intercepted for the time, it would require about thirty days to be cooled down seven degrees, or the difference between the temperature by the Sun and that by the Thermometer and about the same time to be heated to the former temperature, on their return.

To make this effect also more sensible, I have coloured, in the first of the Plates, the spaces between the curves of declination and temperature, **blue** on the side of the year towards Spring, and **red** on that towards Autumn: the one to represent the **cold** produced by absorption in the former season, the other the **heat** derived from radiation in the latter.

* See a copious paper on the subject by Flaugergues. *Journal de Physique*, Octobre, 1818.

FIG. 7.

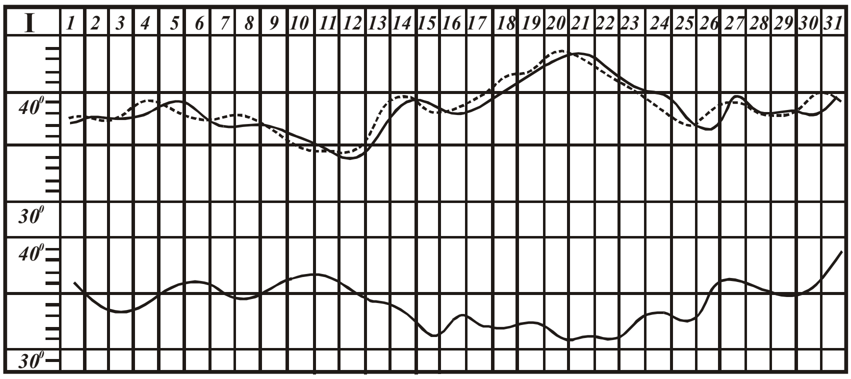
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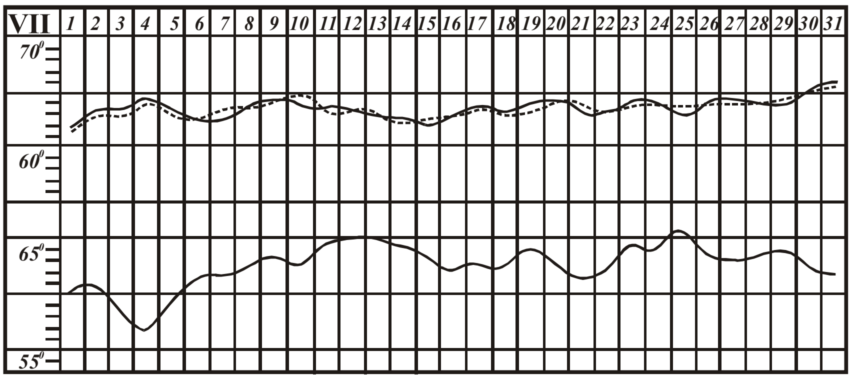
FIG. 8.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EXAMPLES OF OPPOSITE VARIATIONS OF THE MEAN DIURNAL

Before I dismiss this part of the subject, it will be proper to exhibit specimens of the tendency of the average diurnal Temperature to vary, at different periods, in opposite directions.

The upper curve in Fig. 7 (the full line,) is the diurnal mean carried through the **First month**, on the average from 1797 to 1806: the corresponding Temperature, on the average from 1807 to 1816, is represented by the lower curve. The diurnal mean on each of the above averages for the **Seventh month**, is shown by the two curves in Fig. 8. See the same in the Tables D1, D2. From the contrast in direction which prevails through the greatest part of these two pairs of curves, it appears, that the Mean Temperature is subject to these peculiar variations, both in the hottest and coldest months of the year. I shall revert hereafter to the figures, and treat of the probable cause of the opposition. In the mean time the **dotted curves** may serve to explain a discrepancy, betwixt my own diurnal mean observations and those of the Royal Society, which, not being obvious in the Tables of the latter, was not detected till comparison had been fully made of the respective results.

In the Register of the Royal Society, the **minimum** by Six's Thermometer is that of the nocturnal depression **following** the maximum of the day indicated: in my own it is that of the depression preceding it. In averages relating to the month, or any longer period, this difference induces no error in the comparison: but when, as in the present curves, the mean of **each** day is to be exhibited, there results a discrepancy, of which it was not proper to leave the reader ignorant. In the dotted curves, therefore, is shown the mean Temperature by the Register of the Royal Society, as it would have appeared, had it been calculated for each day, according to my own method. The change of the one curve for the other, it will be perceived, in no way affects the contrast I have been insisting on.

VARIATION OF THE ANNUAL MEAN TEMPERATURE, FROM 1817, TO 1831.

The Mean temperatures of those fourteen years, deduced from the Observations contained, (those for 1831 excepted,) in the Second and Third Volumes of this Edition, come out as follows: *viz.*

Annual Mean temperature in the Country.- (See p.4.)	
For the year 1817	47.834
1818	50.028
1819	50.030
1820	47.950
1821	49.810
1822	51.405
1823	48.331
1824	49.714
1825	50.890
1826	51.313
1827	50.390
1828	52.100
1829	47.450
1830	48.850
1831	51.244

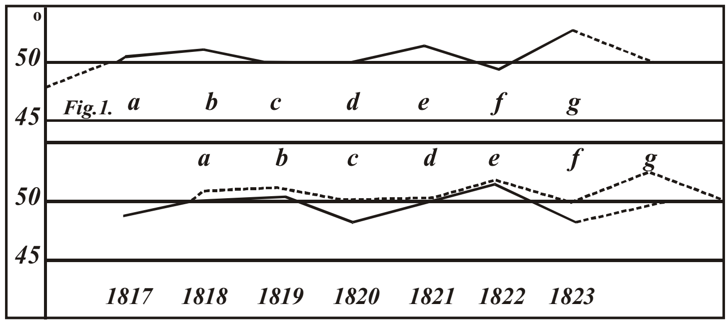
The Mean of the **Climate** by these, from 1817 to 1830, **taken on the years** is 49°721. The same, **taken on the months**, and carried through the years severally, and averaged, is 49.651. That of the preceding twenty years, ascertained in like manner, being 49.649.

I shall exhibit, in its place, the Mean temperature of each Month in detail, as done before for the period of twenty years.

The Average of the Mean temperatures of the years, from 1800 to 1806 inclusive, which I have already stated to form a period of like nature with that of the seven years beginning with 1817, is **for London** 50°942. We have not the Mean Temperatures of these years for the country; but the average excess of the former over the latter, was found to be 1°579, (see p.2). The average of the period from 1817 to 1823 is 49°341. Now 50°942 - 1°579 = 49.363; the average Annual Temperature **for the country** in the former period. Thus it is proved, that the years comprehended in a period of **seven**, which I considered as having occurred once, and recommenced (after an interval of ten years) with 1817, have an average Annual Temperature of 49°35, and we may now expect, should there not be found new features, hitherto unsuspected, in the variation, **a third period of like average temperature**, in the seven years beginning with 1834.

But the near resemblance of these periods is not confined to their average temperature: they agree likewise in their manner of variation; as will appear on comparing them in their curves.- (See p.3, for reference to the Figure.) In Fig. 9 I have placed together the curves belonging to the periods of seven years, beginning respectively with 1800 and 1817.

FIG. 9.



The reader will immediately perceive that the upper curve presents a series **a**, **b**, **e**, **d**, **e**, **f**, **g**, ascending by interrupted movements, the difference between the first and last years being about two degrees and a quarter. Six years of the lower curve (the full line) presents the like character; the difference of the extremes being three degrees and a half: the **seventh** year (1823) shews, in place of the elevation which here occurs in the upper curve, a depression of three degrees, the year before having risen instead of descending. Take the medium height between this and the preceding year, and compare the result with the first, we shall have gained still two degrees on the whole series; thus the ascending character of the series remains.

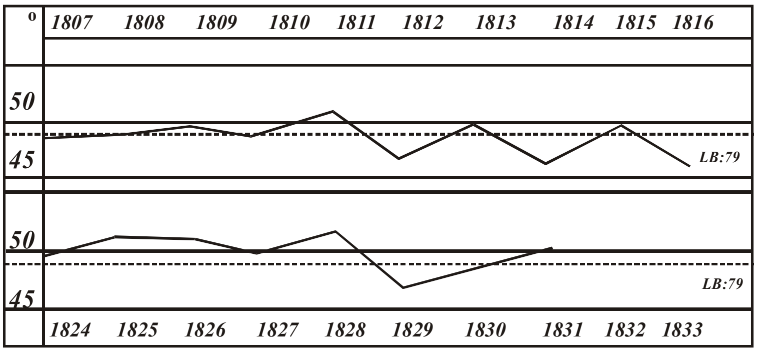
But the most remarkable feature of the case remains to be noticed. If we take the upper curve, and **remove the whole series one year forward**, (as is done in the dotted curve underneath;) it will present throughout a perfect agreement, as to the manner of variation, with the lower; and will end, like that, with an elevation, the depression following which, reduces the Temperature to the Mean of the series: and it is a principle common to the three examples, which we already possess, of the period of **ten** years, to begin with a Mean Temperature. The year 1807, therefore, thus put forward, falls regularly into the next series, as a mean year: as does the year 1824 in the succeeding period of ten years; but by the contrary movement of **ascending** to the mean line.

I stated in the Second Volume of my First Edition, an opinion, that the causes of such periodical changes in a climate must be "Astronomical and not local:" and that "this circumstance, if established, must lead us to expect occasional irregularities, and, as it were intercalations, in the periods; which a long series of years can alone satisfactorily explain." What here appears as an exception, is doubtless therefore a fact in confirmation of the actual existence of a rule for the case. There is plainly, in one or the other series, **an intercalation**. In which of the years, and by what means brought about, we are not at present concerned to inquire; our business is, to state Results as we find them.

Let us then proceed to the Mean Temperatures of other years in the set. With 1821 begins, at a Mean Temperature, an apparent series of **ten years**, resembling the two which have been already made out as beginning with 1790 and 1807.

Eight years of this period have already passed, and with features so closely agreeing with those of the parallel ones in the former Decades, that I shall scarcely need to do more than place them in curves before the Reader; two of them on the next page, in Fig. 10, (the third from 1790 being in Fig. 1, p.3,) the second of these suffices here for the comparison. The eighth year of the lower curve (1831) forms an exception like that already noticed — it **rises** where the corresponding Result in the others is **depressed**. Yet, if we take the mean betwixt 1830 and 1831, and compare it with the Result for 1828, we shall find a depression of two degrees, being a little more than the difference by which 1797 falls below 1794.

FIG. 10.



Still there is probably, here also, an intercalated year; in consequence of which event the low temperature of 1782, 1799, and 1816, which I had anticipated for 1833, **may be deferred to the following year**.

I think it proper here to repeat what I said in 1820 on the subject.- (See the "Summary of the Climate," in the First Edition.) "The Mean temperature of **the Year** is found to vary in different years to the extent of full four and a half degrees; and this variation is periodical. The extent of the periods, for want of a sufficient number of accurate observations, cannot at present be fully determined; but they have the appearance of being completed in **seventeen years**. We may consider one of these cycles as commencing with 1790, or with 1800, and ending with 1806, or 1816. In either case, a year of mean [or average] temperature begins the Cycle; in which the **coldest** year falls at the end of ten years, and the warmest at the end of seven years, reckoning from the coldest; and thus alternately: both together including a complete revolution of the mean temperature from its higher to its lower extreme (or *vice versa*, from the lower to the higher) and back again. The year 1816, which was the coldest of the Cycle, appears to have had its parallels in 1799 and 1782; and now there is every reason to conclude, from present appearances, that the warm temperature of 1806 will re-appear in 1823; which will probably be the warmest, and 1833 the coldest, **upon the whole year**, of a Cycle of seventeen years, beginning with 1817."

The high Annual mean of 1806 re-appeared, actually in 1822; and this was **not** the warmest year of that Cycle, having been exceeded in temperature by about half a degree, by the year 1828, which was the parallel, after the revolution of a Cycle to the year 1811. There is, therefore, still that degree of uncertainty, in anticipations of this kind, which nothing but a long course of observations can remove. Yet we have abundant evidence that cold and wet seasons are coming on. We had, during the superb weather and "Italian skies" of 1825, and its companions in that part of the Cycle, such a profusion of warmth in advance, that we must now be greatly in arrear on the cold side, and must expect to pay, in inclement weather and severe frosts for that indulgence.

It may be as well to show this by a few plain figures. We have proved that our Temperature varies by periods, which agree very closely in their averages. Now the average temperature of the years, from 1807 to 1816 inclusive, is 48°79 — the **total** of the Annual temperatures composing the series being 487.917. The total of these from 1824 to 1831 inclusive, is 400.428 — the average Annual temperature 50°05. Then 487.917 - 400.428 = 87.489, leaving for the years 1832 and 1833 only 43°744 apiece, which is 2°828 below the Temperature of 1816, when the Thermometer went down five degrees below **Zero** — and 3°223 below that of 1814, when the Thames was frozen over. It is, however, scarcely probable that two such years should now (any more than at that period) occur in succession.

Whether the depression which is yet to come shall be found in one or two seasons close at hand, or shall in part be distributed through a number of bleak cloudy springs, and cold summers following, is what I presume not to determine. I remember, before I began to keep a Register, to have witnessed a succession of such seasons — the more noticed perhaps, because feeling was not then strictly subjected with me to the test of the Thermometer. But without some such mitigation of the terms, it is not easy to discover how we are to escape **a winter, or winters, more destructive to vegetation, and harder to animal life to endure, than any within the actual knowledge or memory of observers of this Climate now living**.

EXTREMES OF THE YEAR, FROM 1817 TO 1831.

The Thermometer stood in the year

					Range	Medium
1817	at	86°	and	17°	69	51.5
1818	….	93	…..	16	77	54.5
1819	….	86	…..	10	76	48
1820	….	91	…..	0	91	45.5
1821	….	81	…..	18	63	49.5
1822	….	92	…...	14	78	53
1823	….	82	…...	4	78	43
Averages		87.3		11.3	77.4	49.3

In this series, the Mean for the Climate obtained by an average of the Medium Annual temperatures, differs not quite half a degree in excess, from the Mean which was obtained by a like operation **on the ten years from** 1807 to 1816, (see p.11, the Table and the remarks following it.) I consider this excess as being probably due to the change of station, and to the state of the surrounding country in respect of population.

The Thermometer stood in the year

					Range	Medium
1824	at	88°	and	19°	69	53.5
1825	….	97	……	21	76	59
1826	….	92	……	10	82	51
1827	….	89	……	10	79	49.5
1828	….	89	……	24	65	56.5
1829	….	81	……	16	65	48.5
1830	….	90	……	8	82	49
1831	….	87	……	18	69	52.5
1832	….		……			
1833	….		……			

The two years left blank, when inserted, will complete the third **decade** of Results exhibited in this work. Had I deemed it expedient to wait the fulfilment of the time, I have no reason to doubt that an average equally near to the Mean of the Climate would have resulted from the Medium temperatures contained in the fourth column. But, in order to confirm what has been said respecting periods, let us compare the numbers, **that would now stand** at the foot of each Column, with those under the several columns of the preceding **decade**: p.18.

In the first place, instead of 85.3, the average **Maximum** of the year, we should have here 89.1; and in place of 12.4, the average **Minimum**, we should have 15.7; the one near four degrees, the other above three, **in excess**: the average Medium being 52.5, instead of 48.85, is near three degrees and three quarters in excess upon the last Decade. All these results show plainly **that the lowest numbers are wanting in the series**.

It may be thought by superficial observers, that a hard winter does no harm to the crops, if there be but snow on the ground to cover the blade. But **extreme** continued cold never fails, I believe, in this climate, to be attended with **deep** snows in most parts of the country. And it makes, I observe, a great difference in the springing of a field of Wheat, whether there has been a foot or a foot and a half, or only an inch or two of this covering upon it. Though the plant, in wet soils, may have escaped the being turned out of ground by the rising of the frozen crust containing it, or the being absolutely killed in part by mere cold, in drier and more exposed places, yet the melting into the soil of a large mass of snow, has so chilling an effect on it, that it is long before the sun's rays can revive the plant; which has been weakened further by the smothering it had undergone beneath the snow. For a certain portion of **light** is as needful as warmth itself, to the healthy vegetation of whatsoever crop we sow; and a certain depth of snow deprives it of this, in considerable measure. Of the salutary stimulant effect, and covering shelter to the crops, of a moderate snow in our ordinary frosts, I have never doubted.

Those who are accustomed to use their eyes and judgments, and who wish well to their country, will not find it an irksome task, I trust, to weigh the evidence here adduced of periodicity in our seasons. And should they incline to put the farmer on his guard respecting the present tendency in them to cold and wet, two things, (beside the ordinary care of drainage, &c.) appear to me to require his attention. The first, **the state of his manure**. I believe that much, if not most of the evil called **rust** and **mildew**, might be averted by the practice of thoroughly **pickling**, in the drainage of the stable and fold-yard, **every portion of the straw** thus employed. The saline contents of this liquor, so commonly suffered to overflow into the drain, are, I have reason to believe, unfavourable to the growth of the scarcely visible seeds of that minute **fungus**, (for such it is found to be by microscopic examination) which in a season of "rust" is growing out of innumerable longitudinal fissures in the outer smooth skin of the straw. This skin moreover, like that on the sugar-cane, is probably composed in part of **Silex**, an earthy element which the roots cannot take up, until dissolved in water; and this solution is chiefly effected by means of an **alkali**, produced by the decomposition of the straw of the former year; aided by the saline matter added to it in the dung and urine of the cattle.

Now straw, by simple rotting, turns to a black inodorous, and (when washed by rain,) insipid mould, very different from good moist dung; and however well this may supply **Carbon**, an element also essential to the new vegetation, it cannot, I believe, be equally effective in causing **a solution of the Silex contained in the soil**. If the plants have enough of the latter, the straw will be well covered with a hard outer coat. If the due supply of silex be wanting, the rind will be faulty, and the substance of the straw will be accessible to the roots of this little parasite: they will strike into it and grow; and the fungus will be propagated from year to year, by the straw, containing its seeds, being laid in a crude state on the land. The rust is found on the part of the stem exposed to the air, and on the leaves, **not on the part covered by the sheath**; therefore comes not from within the plant.

I might go further, and insist on the probable effect of this practice **in keeping off vermin**, by means of the Ammonia extricated from the salts of the urine by lime, laid on, or contained in the soil. The odour of seed which has been "in steep" for sowing, shows this principle in abundance; but what has been said may suffice as a hint to the **good** farmer, **to let nothing run to waste that can**

make straw into manure, whether out of house, fold, or stable: the **sloven** will go on as he has been used to do, and will lose by it.

The mixture of a proportion of rye with wheat is here also found by experience to be useful. It rises quicker and stands higher than the wheat; and the ears, when formed, must tend greatly to protect the latter from blight and cold, in such seasons.

The second point regards sowing, and lies in a smaller compass. It would be prudent, when unfavourable seasons are expected, **to sow more seed on the same breadth of land**. This would allow something for the loss of plants killed by wet and frost; and with a thicker growth the weeds would be better overcome. In this latter point of sowing thick I may, however, be contradicting the experience of some; and as soils differ much, and management with them, such persons, having this safer guide, will doubtless continue to follow it, in preference to theory.

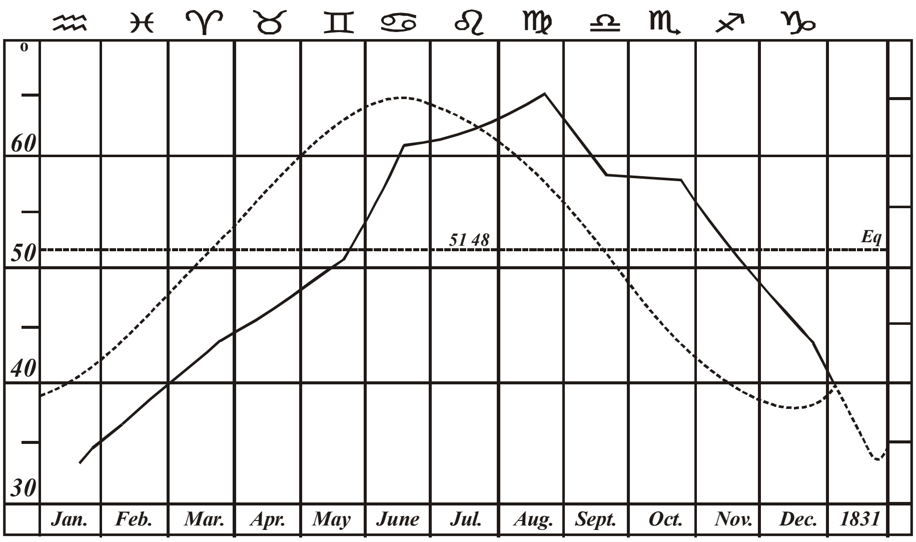
The improved state of our Agriculture, throughout the country, may, lastly, encourage us to look forward with the hope of encountering the difficulties of unfavourable seasons better than formerly.

There is, however, one circumstance which remains to be mentioned. I observe that vegetable matter, soaking in water strongly impregnated with the animal excretions, never decomposes in a way to give out that very offensive and highly insalubrious gas, which is so largely produced by a flax pit; the fermentation continues **vinous**, and the effluvia of the dung are, I believe, in no considerable degree injurious to the purity of the atmosphere.

MEAN TEMPERATURES OF THE SPACES INCLUDED IN THE SEVERAL SIGNS OF THE ZODIAC.

In describing the progress of the Diurnal mean temperature through the year, I have had frequent occasion to notice the relation of the heat to the Sun's place in declination. From the strict manner in which the one is subject to the other, it is evident that the most accurate way of stating the Mean temperature, Monthly, will be to take it upon the average of the days comprehended in the several signs of the Zodiac.

FIG. 11.

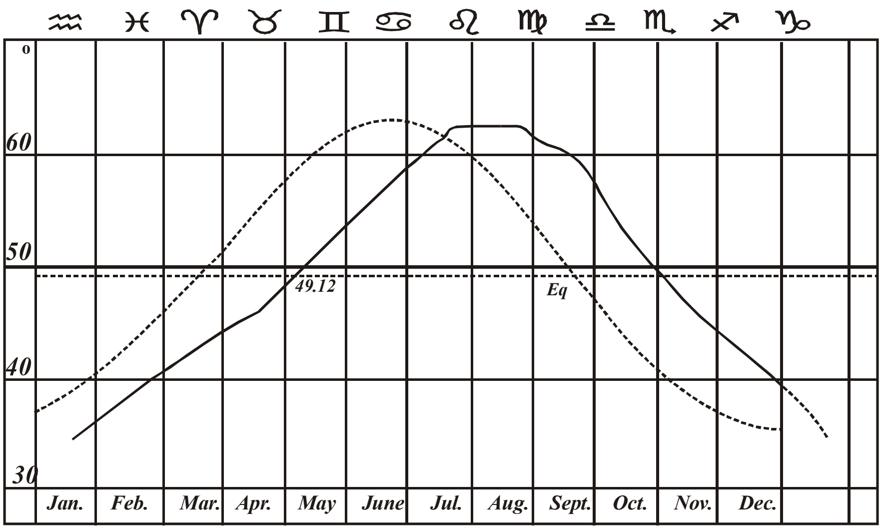


The following are the Mean temperatures of the spaces included in the several signs, from 22d December, 1830, to 21st December, 1831:

Average of	29	days in	Capricorn	33.535
…………	30	………	Aquarius	39.350
…………	30	………	Pisces	43.366
…………	30	………	Aries	47.183
…………	31	………	Taurus	50.965
…………	32	………	Gemini	61.220
…………	31	………	Cancer	63.032
…………	31	………	Leo	65.580
…………	31	………	Virgo	59.195
…………	31	………	Libra	58.800
…………	30	………	Scorpio	50.900
…………	29	………	Sagittarius	44.707
…………	366	Mean of the twelve		51.486
Mean of the Solar Year at large				51.705

In Fig. 11, the Mean temperatures given above are placed in a Curve, by the side of another, representing (on the same scale) as for the months in Fig.2, p.7, which see) the Sun's progress in declination through the Year. This Curve exhibits irregularities in the gradation of Temperature, such as in the Curve, Fig. 12, **deduced from an average of the Mean temperatures of the like spaces**, **in the years from** 1817 to 1823, are very nearly done away. I have here distributed the days to the signs by the scale of their mean duration, which makes them fall into better symmetry.

FIG. 12.



For the like reasons as those which prevented my continuing the **Monthly** averages, I have decided on leaving those on the Signs, for the years from 1824 to 1833, until the Decade shall have run out.

The numbers are as follows:

Average of	29	days in	Capricorn	34.315
………	30	………	Aquarius	38.481
………	30	………	Pisces	40.302
………	30	………	Aries	46.009
………	31	………	Taurus	51.979
………	31	………	Gemini	57.023
………	32	………	Cancer	62.087
………	31	………	Leo	62.843
………	31	………	Virgo	59.203
………	30	………	Libra	51.433
………	30	………	Scorpio	45.193
………	30	………	Sagittarius	40.583
………	365	Mean of the twelve		49.121
Mean of the Solar Year at large				49.325

AVERAGE MONTHLY MEAN TEMPERATURES, FROM 1817 TO 1823.

The Results obtained from a twenty years' series of these were made the basis, in the early part of this article, of a comparison between the London and country temperatures, which was illustrated by a set of Curves. It is proper that I should exhibit a continuation of these to the extent at which it can at present be done satisfactorily; which, for reasons already given, is only to the year 1823 inclusive. The following are the Averages in question.

Month		In the Country	In London	Difference
1	Jan.	36.39	39.10	2.71
2	Feb.	38.38	41.31	2.93
3	Mar.	42.39	44.81	2.42
4	April	47.42	49.94	2.52
5	May	53.77	56.16	2.39
6	June	59.97	6213	2.16
7	July	62.45	63.95	1.50
8	Aug.	62.21	64.07	1.86
9	Sept.	57.35	59.77	2.42
10	Oct.	49.01	52.04	3.03
11	Nov.	44.55	47.46	2.91
12	Dec.	37.22	40.61	3.39
	Mean	49.26	51.78	2.52

The Results from which I have computed the second set of Averages, are those published in the Philosophical Transactions; and the daily observations which afford them are stated to have been made at Somerset House, twice a day, at 7, 8, or 9 a.m., and at 2 or 3, p.m. according to the season. They are placed by the side of other daily observations, contained in a column headed "Six's Thermometer:" and, as the **Results** of the latter are not given in the Table at the end, I conclude that those I have here quoted have been found to **afford the more consistent Mean**.

We find here the same superiority of Temperature as in London; and the mean difference greater by almost a degree than in the former comparison; but the gradation likewise of the excess on the lower temperature differs, being as follows:

$$\frac{1}{13}, \frac{1}{13}, \frac{1}{17}, \frac{1}{18}, \frac{1}{22}, \frac{1}{28}, \frac{1}{41}, \frac{1}{33}, \frac{1}{23}, \frac{1}{16}, \frac{1}{15}, \frac{1}{11}$$

The greatest proportionate excess of London, instead of being found in the First month, falls here in the Twelfth; and the least in the Seventh, in lieu of the Fifth. The difference in the mode of observing may have given rise to this; but I am not inclined to lay any great stress on these numbers, further than as a general confirmation of what has been before stated on the subject in this work. The excess of the temperature of London over that of the country is increasing; and it continues to be greatest in the Winter.

TEMPERATURES OF SUMMER AND WINTER, AND OF DAY AND NIGHT, FROM 1817 TO 1823.

If we take the Mean temperatures of the several Signs as just now given, in the years from 1817 to 1823, and average those from *Aries* to *Virgo* inclusive, we obtain the Temperature of 56°524, **as that of the Summer half year**; and by the like operation with the Signs from *Libra* to *Pisces* inclusive, the Temperature of 41°718, **as that of the Winter half year**; the difference between the two being 14°806.

Now, on p.19, it has been stated that the Mean of the **Maxima**, or highest temperatures by day, on an average of twenty years, was 56°345, and that of the **Minima**, or lowest temperatures by night, 42°204, the difference 14°141.

Thus we have a further and most beautiful illustration of the order and symmetry of the seasons in our Climate, when examined in the Results of Observations carried through a regular period of years. **The difference between the Mean temperatures of day and night coincides to a fraction of a degree with the difference between those of Summer and Winter!**

In the Table E1, at the end, are given under the titles **Higher** and **Lower mean**, the averages of the maxima and minima of the daily temperature **for each Month of the several years**, from 1817 to 1823.

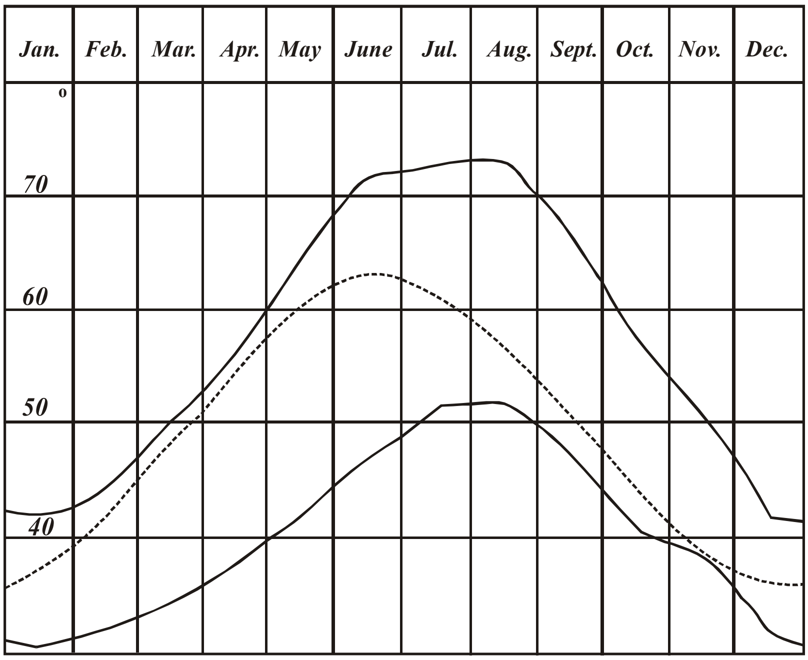
From the numbers in this Table, averaged under each Monthly column **upon seven years**, the following Results are drawn. See first the former results at p.19, the Table and remarks.

Month		Mean of the greatest heat by Day	Mean of the greatest heat by Night	Difference
1	Jan.	41.860	30.663	11.197
2	Feb.	44.860	32.150	12.710
3	Mar.	50.139	34.667	15.472
4	April	56.733	37.776	18.957
5	May	65.198	42.769	22.429
6	June	72.111	47.820	24.291
7	July	73.114	51.359	21.755
8	Aug.	73.454	51.484	21.970
9	Sept.	67.323	47.380	19.943
10	Oct.	57.170	40.851	16.319
11	Nov.	50.353	38.761	11.592
12	Dec.	42.796	31.693	11.103
	Mean	57.926	40.614	17.312

It appears by these numbers, that the difference between the Extreme Temperatures of day and night was greater by above three degrees upon these seven years, than in the twenty years preceding; and the divergence in either direction has been nearly equal, *viz.* the days warmer by 1°581, the nights colder by 1°590. It is possible that the lesser divergence may re-appear in the Decade now proceeding; and we should also take into the account the fact, that the period of twenty years, before exhibited, contains, besides a balanced Cycle of seventeen, the three latter years of a former Cycle, two of which were cold ones. The ten years, from 1807, average 50.364; the seven years preceding them 50.912, both in London. I have not thought it expedient to run the average on to the year 1830, (the observations of which are contained in this work,) or to compute it on those latter seven years, (part of a Decade) by themselves; being quite satisfied, that in neither case should I obtain a true and consistent standard.

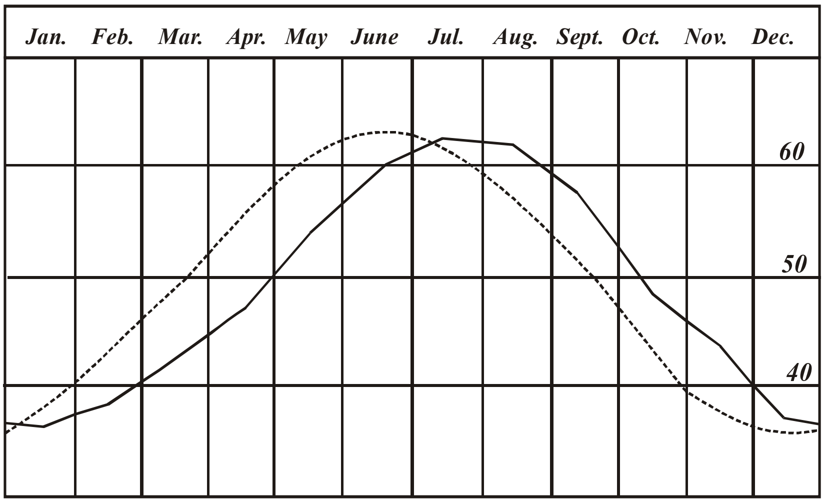
The variation proceeds through the months with sufficient regularity, both in the Higher and Lower mean, to be worth preserving in Curves; which I have presented, as in Fig. 2, in comparison with the Curve of the declination: See, first, Fig. 13.

FIG. 13.



The Temperature advances, in both curves, with an accelerated movement through the former part of the year. In summer the heat by day is sustained (by means of the heat given out by the soil) to the end of the season; after which it descends rapidly through the autumnal months, in which October is marked by a slightly increased depression. This depression is conspicuous in the lower curve, and is probably due to the return of radiation, after the cloudy nights of the latter part of summer. It is compensated in the following month, where we find an equally conspicuous elevation. The latter is probably the result of the prevalence of strong Southerly winds in the nights of November, not fully compensated by Northerly in any part of the period. This is not the case with the Eleventh Month, in the Decade preceding; the average of the month is, there, lower by 3°622, and the numbers in the column allotted to it in Table A show, by inspection, that it is much colder in the Decade than in the **Septenary**.

FIG. 14.



MEAN TEMPERATURES, &c. concluded

The **Monthly Means** in the Country, **averaged on the seven years**, from 1817 to 1823, present the fine Curve, Fig. 14, the number of which are as follows:

1	Jan.	36.261
2	Feb.	38.505
3	March	42.403
5	April	47.254
5	May	53.983
6	June	59.965
7	July	62.236
8	Aug.	62.467
9	Sept.	57.351
10	Oct.	49.010
11	Nov.	44.557
12	Dec.	37.244

The average Annual Temperature deducible from the elements of this Curve is 49.269. The average on the seven years, from 1800 to 1806 was 50.912, the observations being in London. The average excess of London, on twenty years, was 1.579. But 50.912 -1.579 = 49.333, which is as near a coincidence of the two Septenaries, as in the present state of our observations we could be required to show.

In the general Table, A2, are given the Monthly Mean Temperatures from 1817 to 1831; and in the general Table, B2, the Extremes for each month, with the attendant winds for the like period.

The Monthly Means, averaged on the 14 years, from 1817 to 1830, are as follows: compare with these the averages on twenty years, at p.6.

1	Jan.	35.837
2	Feb.	38.418
3	March	42.413
5	April	48.079
5	May	54.349
6	June	60.337
7	July	63.777
8	Aug.	62.331
9	Sept.	57.905
10	Oct.	50.000
11	Nov.	43.502
12	Dec.	38.865

The annual Mean for the Climate, brought out by these numbers, is 49.651: and that deducible from the Temperatures given in p.6, third column, is 49.649. There are, in the **twenty** years, two cold ones, 1797 and 1799, which are wanting in the incomplete series of fourteen, here presented: but the former period is complicated with the artificial heat of London, in which this portion of cold disappears.

I have assumed, on the evidence of those **twenty** years, the Temperature of the city, at 50°5, and that of the country at 48°5. It will be seen that there is no reason, at present, to make any change in these numbers; the station of the Laboratory being intermediate, in point of added heat, between the two.

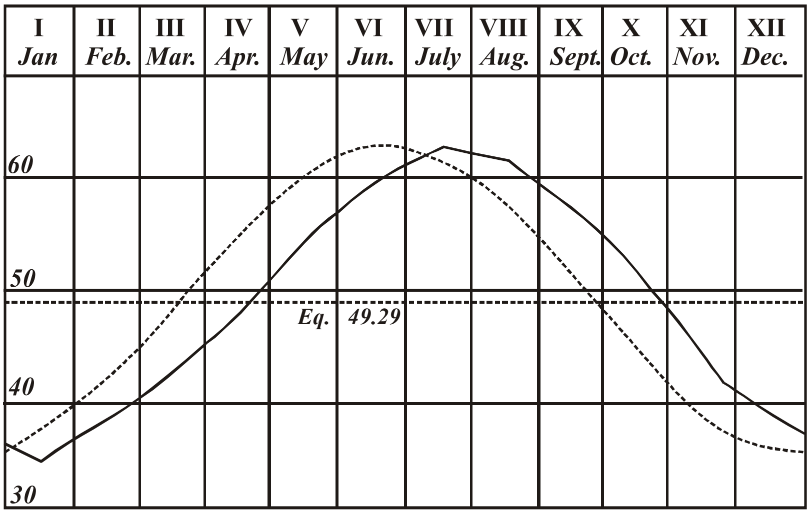
The Monthly Averages for the whole of the observations **made in the country**, detailed in this work, through a period of twenty-four years, ending with 1830, are as follows: I have added to these the greatest variation of the Mean temperature of the Month during the time.

Month		Mean Temp.	Variation
1	Jan.	35.140	13.95
2	Feb.	38.997	12.26
3	March	42.030	11.20
5	April	47.567	8.64
5	May	54.937	11.99
6	June	59.613	9.36
7	July	63.190	8.68
8	Aug.	61.950	8.89
9	Sept.	57.187	9.80
10	Oct.	50.123	12.88
11	Nov.	42.432	10.19
12	Dec.	38.343	12.42

The Average Annual, or Climatic Mean Temperature, brought out by these numbers, is 49.292. I have already stated the reason why I do not consider these averages as correct, when drawn from any other periods than such Cycles as have been now proved to obtain in the variation, in our Climate. The present, of twenty-four years, begins with the Decade 1807-16; but it wants the coldest years of the next Decade, now running, and also the corresponding Septenary to the one which it contains. Compare the Fig. with Fig. 2.

It has been remarked long since, that the Mean Temperature of the months of April and October approach near to the Mean of any Climate, in these latitudes. In the present case we have the former at 47.567, which is 1°725 below; and the latter at 50.123, which is 0.831 above the Climatic Mean shown by the Table: and if we compare them with the Mean of 48°79, they will be found to diverge by almost equal quantities from it. The defect in the one is undoubtedly due to absorption of heat by the soil, the excess in the other to its restoration to the atmosphere by radiation.

FIG. 15.



I have inserted, in the Tables of this Second Edition, a number of Columns of Observations with a second Thermometer, which differing as they do, a superficial reader might think they tend to throw a degree of uncertainty upon the Results adopted. My own conclusion upon the matter is the reverse. I am always glad of collateral observations, which appear to come within any reasonable limits of correspondence; knowing that Thermometers, differently exposed, may give **Maxima** and **Minima**, which scarcely in two days of any month shall perfectly agree, and yet (by the effect of those compensations which are found to pervade the whole of this science) in their Mean Results shall correspond nearly enough for any practical purpose.

It appears, from the observations which I have caused to be made for eight years past, at the Friends' School at **Ackworth**, that the Mean Temperature, here, is 1°30 lower than at Stratford. The difference of Latitude is 2°11', and the exposure **South**.

OF THE PRESSURE

Next to the Temperature, the variable **Pressure** of the Atmosphere, as indicated by the **Barometer**, claims the attention of those who are accustomed to the use of philosophical instruments. Indeed, the elegance of its construction, the facility of observing its changes, perhaps also something mysterious and imperfectly understood in its indications, have made this instrument but too successful a rival to the Thermometer: and we are probably deprived, by this preference on the part of observers, of many useful results, which the latter, skilfully used might, in different situations, have furnished to science. The Barometer, when we contemplate it as a counterpoise to the weight of the atmosphere, is certainly a curious instrument: its movements, unlike those of the Thermometer, which relate only to surrounding space, bring us intelligence from the very surface of the aerial ocean, many miles above our heads. Here, probably, exist elevations and depressions of prodigious extent; and as the representative in miniature of those tides in a sea without shores, its variations deserve, in point of theory, greater attention than has been hitherto bestowed on them: for the Barometer has been more observed than studied, and our knowledge of the principles on which its changes proceed is as yet little better than empirical. Hence frequent disappointments to those who trust to it as a **weather-glass** — unless indeed it be assisted by attention to natural prognostics, and to the humbler, but not less certain indications of the Thermometer and Vane. But our present business is, not so much with the theory of its movements, as with their **General results**; in which we shall find matter sufficiently interesting, and allied to the previous facts of this inquiry.

MEAN OF THE BAROMETER FOR LONDON

The mean height of the Barometer as deduced from 124 Lunar periods in this work, beginning Dec. 10, 1806, and ending Dec. 11, 1816, including a space of **ten years**, is 29.823 in.

The mean height for the ten years by the Calendar, from 1807 to 1816, inclusive, as deduced from the yearly results in the Philosophical Transactions, is 29.849
and for the ten years preceding 29.882

Average at London on 20 years ending with 1816 29.8655

The Barometer employed at Somerset-house is uniformly stated, during this period, as situated 81 feet above the level of low water spring tides in the Thames. I am not prepared to state with equal precision the different heights (for the most part inferior to this) at which the observations contained in my Tables were made: nor is it of importance, as I do not propose in this instance to incorporate the results of that register with my own, for the purpose of drawing more extensive general inferences. The mean of 29.823 inches is therefore to be considered as the standard, to which I refer my own observations, for the ten years which are now to be more particularly examined.

YEARLY RANGE AND EXTREMES OF THE BAROMETER FOR TEN YEARS

The General Table C exhibits the greatest and least elevations of the Barometer in each month, for the ten years from 1807 to 1816, together with the attendant winds. To the maximum heights of each year I have annexed the mark, [*] and to the minima, the mark [†]. The reader will perceive that the whole of the yearly **maxima** stand connected with **Northerly** winds, and the whole of the yearly **minima** with **Southerly**. Indeed, this rule holds generally throughout the Table, as to the monthly extremes also; and I need scarcely refer in this place to the fact, so long known and proved, that Northerly winds raise the Barometer, while Southerly ones depress it.

Of the yearly **maxima**, the greater number occur within the first three months of the year, and the rest about the end of it. The yearly **minima**, with a single exception, fall within the last three months. Thus there are six months, of Spring and Summer, in which, with a single exception in ten years, the Barometer visits neither extreme of its yearly variation: while the higher annual extreme is chiefly the product of Winter and the lower one of Autumn.

The following Table, drawn from the results of Table C, will serve for more easy reference.

Year	Mean of 12 greatest elevations	Mean of 12 greatest depressions	Medium of elevations & depress.	Highest observation in the year	Lowest observation in the year	Range for the year
1807	30.310	29.167	29.738	30.60	28.68	1.92 in.
1808	30.338	29.263	29.800	30.71	28.72	1.99 in.
1809	30.295	29.088	29.691	30.49	28.25	2.24 in.
1810	30.323	29.327	29.825	30.51	28.50	2.01 in.
1811	30.302	29.195	29.748	30.61	28.65	1.96 in..
1812	30.266	29.279	29.772	30.51	28.53	1.98 in.
1813	30.314	29.214	29.764	30.50	28.64	1.86 in.
1814	30.266	29.190	29.728	30.42	28.22	2.20 in.
1815	30.309	29.136	29.722	30.58	28.85	1.73 in.
1816	30.327	29.023	29.675	30.62	28.53	2.09 in.
Average	30.305	29.188	29.746	30.555	28.557	1.998 in.

The average of the third column, or the **medium** between the average elevations and depressions, is near eight hundredths of an inch below the **mean height for the climate** (or 29.823 in.), the reason of which is, that the depressions occupy a smaller space of time than the elevations; in consequence of which a less proportion of them comes into an average founded on daily results.

The **Average annual range** for 10 years is very nearly 2 inches; the range varies in different years about ½ an inch.

The **greatest elevation** in 10 years appears to have been 30.71 inches. This took place on the 24th of Second month, Feb. 1808: it was introduced by NE breezes, with hoar frosts at night, and a temperature of 39° in the middle of the day. But this is not quite the higher extreme of the climate: for on the 7th of the same month in 1798, the Barometer rose to 30.89 inches: the elevation being in like manner introduced by a gentle NE wind, with hoar frosts at night, and a temperature of 39° in the middle of the day on which it took place. I observed on this occasion, that the air at Plaistow was filled with a dense mist: but in 1808 I believe it was clear at the time. The coincidence of circumstances in some other points is remarkable.

The **greatest depression** in 10 years occurred in 1814, on the 29th of the First month, Jan. when the Barometer descended to 28.22 in. It is very nearly equalled by a former one, on the 17th of Twelfth month, Dec. 1809, which was 28.25 in. Both were introduced by strong Southerly winds. Having been on each of these occasions at home, and attentive to the phenomena, I must refer the reader to the accounts of them, in the Notes and Results under Table XXXIX, and the Results under Table LIX, in my second volume. The depression of 1814, it will be observed, took place at the first remission of the severe cold of that season, by which the Thames was frozen over.

Neither extreme for the year is ever produced very suddenly. In 1798, the Barometer took eight days, to rise from 29.15 to 30.89: in 1814, five days, to fall from 29.88 to 28.22. The great depression of 1809 was in progress for several weeks, before it arrived at the crisis: but of this I shall have occasion to treat hereafter. There is also, as in the case of Temperature, a consistency between the annual extremes: in those years in which the Barometer falls very low, it does not rise so high as in others, and *vice versa*: the same gradation from year to year which appears in the Temperature, is also occasionally found in these results.

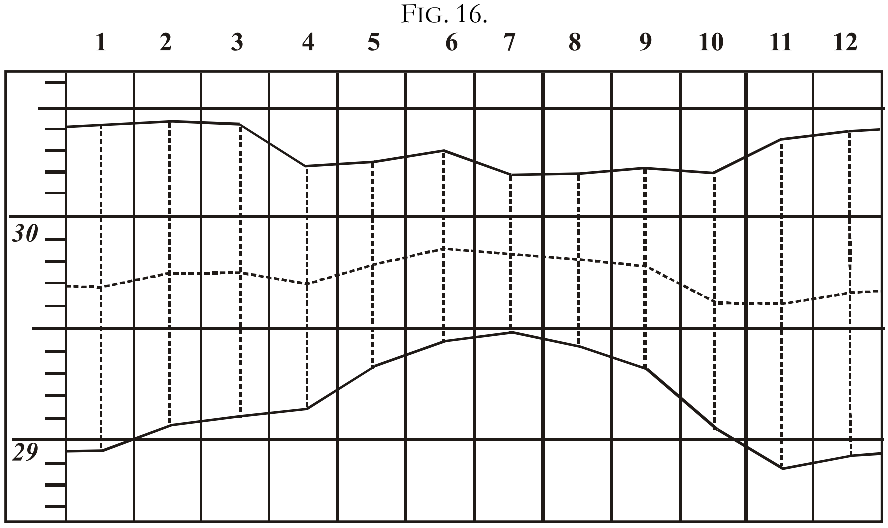
MONTHLY RANGE AND EXTREMES OF THE BAROMETER ON THE AVERAGE OF TEN YEARS

This part of the subject presents gradations almost as regular and striking as those of the Monthly Temperature: to exhibit which it will be necessary to have recourse to curves, and to a second statement in figures, drawn from the General Table C. The present Table consists entirely of results found on taking the columns vertically by the month; as the other did of those found on taking the lines horizontally for the years.

Month	Average of Maxima	Average of Minima	Difference or mean Range	Greatest elevation in 10 years	Greatest depression in 10 years	Difference or full Range
1. Jan.	30.400	28.971	1.429	30.60	28.22	2.38 in.
2. Feb.	30.419	29.069	1.350	30.71	28.70	2.01 in.
3. Mar.	30.405	29.106	1.299	30.61	28.81	1.80 in.
4. Apr.	30.233	29.154	1.079	30.36	28.74	1.62 in.
5. May	30.251	29.337	0.914	30.42	28.90	1.52 in.
6. June	30.283	29.452	0.831	30.40	29.15	1.25 in.
7. July	30.182	29.491	0.691	30.39	29.40	0.99 in.
8. Aug.	30.193	29.434	0.759	30.26	29.24	1.02 in.
9. Sept.	30.232	29.334	0.898	30.40	28.86	1.54 in.
10. Oct.	30.212	29.056	1.156	30.35	28.53	1.82 in.
11. Nov.	30.357	28.899	1.458	30.62	28.50	2.12 in.
12. Dec.	30.407	28.957	1.450	30.62	28.25	2.37 in.

The upper curve in Fig. 16 shows the manner of variation throughout the year of the average higher Extreme, or mean of ten maxima; the lower curve that of the average lower Extreme, or mean of ten minima. I have added a medium curve between the two; together with a set of dotted perpendiculars, which express the **mean range** for each month.

FIG. 16.

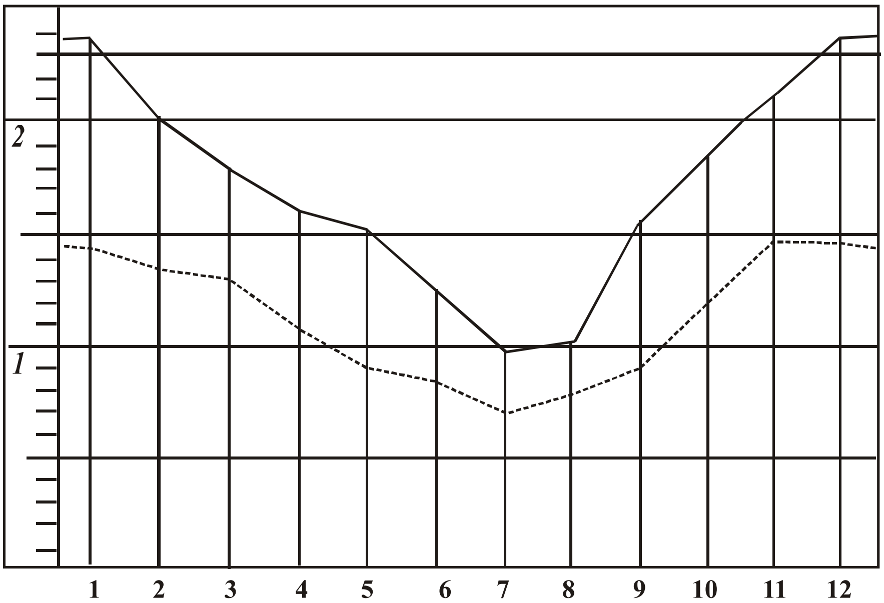


The **great elevations** of the Barometer, it appears, take place in the winter months; and during seven months of the year, from the Fourth to the Tenth inclusive, they fall off, to the amount, as the fourth column shows, of a quarter of an inch on the whole.

The **depressions** too, are most considerable in the winter half year, being at their full extent in the Eleventh month: from whence they decrease to the Seventh and then increase again; the total difference exceeding half an inch: the progress of the series through the six months of summer forms a regular curve, ascending and descending; the remainder of it an ascending line.

In consequence of these movements of the **maxima** and **minima** in opposite directions, the **Monthly** range is shortened as the Summer comes on, and lengthened again in proportion as that season gives place to Winter. Fig. 17 represents this gradation; the full line being the curve of the full Monthly range on an average of ten years, the dotted line that of the mean range; the perpendiculars marking the extent of range in each case. It is about an inch on the whole in the middle of Summer, and more than 2⅓ inches in the middle of Winter. The progress of the mean range through eight months, from the Third to the Eleventh, forms again a regular curve, in descent and ascent; the remainder a descending line.

FIG. 17.



From the greater tendency of the **depressions** to go off in the Summer, the Medium curve has its higher points in that season, notwithstanding the lower level of the great **elevations**. In this respect, as will be shown hereafter, the curve of the **medium** agrees with that of the true **mean**, deduced from all the observations; and each of them proves that **on the whole, the weight of the atmosphere is greater in summer than in winter**.

MEAN OF THE BAROMETER FOR LONDON, &c. CONTINUED.

The Results of my subsequent observations have, in this department also, established satisfactorily the conclusions formerly come to.

The General Table, F2, exhibits a series of Mean heights of the Barometer, taken **by the phase** on Lunar periods, extending through a Septenary of years, from 9th Dec. 1816 to 6th Dec. 1823. These Results are classed, for the purpose of an average, on the principle adopted before for Table F. The general average of the **Septenary**, thus obtained, is 29.826 inches: that of the **Decade**, ending 11th Dec. 1816, was 29.823 inches.

I shall defer the particular examination of these Results to the part of the work in which the subject of Lunar periods is treated; only adding, here, that the average of another seven years' observations, in mean results arranged **by the declination**, extending from Dec. 28th 1823, to 25th Dec. 1830, (part of the Decade now running,) is 29.859 inches. The remaining years of this period, when added, may probably reduce the General Average to the level shown by the two former: and being now well satisfied of the fact of a variation in our Temperature, and consequently in the other phenomena of the Climate, regulated by such periods, I shall hereafter take my Averages on them, to the exclusion of all calculations on Barometrical and Thermometrical observations taken at random. The General average of the Laboratory Barometer, situated about forty-three feet by this mode of measurement lower than the Barometrical Clock, when it stood at Tottenham, (and in which some of the lowest winter points are undoubtedly wanting,) is, for the seven years from 1824 to 1830, 29.959 inches. The Monthly Mean heights on which this Average is founded, and the corresponding ones obtained by the Clock at Tottenham, and which present a General Average of 29.855 in. will be found in the General Tables F3, F4, at the end of the volume.

YEARLY MEAN HEIGHTS OF THE BAROMETER FOR THE PERIOD INCLUDED IN THE OBSERVATIONS.

The following are the Yearly Mean heights of the Barometer for the years from 1807 to 1831. The first eight years are deduced chiefly from observations with the common or Wheel Barometer, (of which an account is given in the **Introduction**,) at Plaistow, Stratford, and Tottenham. The next period of thirteen years, from 1815 to 1827 inclusive, from the Clock Barometer at Tottenham, with a few intervals (which are marked) supplied from the other set continued at the Laboratory. The last four years, three months excepted at the beginning, and with a few days supplied by the common method, are from the same Instrument, situated at my house at Ackworth. I have made, in the years 1815, 1816, and 1817, a deduction of 0.1 in. from the actual results, on account of the scale having been wrong placed in the setting up of the Clock, **and raised that space in the beginning of** 1818.

The Mean height of the Barometer for London,*

For the year 1807,	ascertained in the common way is	29.823
1808	……………………………………	29.872
1809	……………………………………	29.797
1810	……………………………………	29.844
1811	……………………………………	29.847
1812	……………………………………	29.844
1813	……………………………………	29.877
1814	……………………………………	29.799
1815	……………………………………	29.803
1816	……………………………………	29.774
	The Mean of the Decade thus obtained is	29.828
For the year 1815	by the Clock	29.766
1816	……………………………………	29.648
1817	……………………………………	29.733
1818	……………………………………	29.826
1819	……………………………………	29.831
1820	……………………………………	29.839
1821	……………………………………	29.805
1822	……………………………………	29.889
1823	……………………………………	29.763
	Mean of the Septenary, 1817-23	28.812
1824	……………………………………	29.878
1825	……………………………………	29.987
1826	……………………………………	30.033
1827	……………………………………	29.938
1828	……………………………………	29.814
1829	……………………………………	29.688
1830	……………………………………	29.671
1831	……………………………………	29.653
	Mean of 13 year's observations by the Clock Barometer, at Tottenham	29.841

*For the difference of level between Ackworth and London I have not introduced any correction; but the following may serve for an approximation.

Mean height of the Royal Society's Barometer for 1827	………..	29.865
1828	………..	29.840
1829	………..	29.860
	Av.	29.856
Ditto of the School Barom. For 1827	………..	29.85
1828	………..	29.830
1829	………...	29.843
	Av.	29.840

School Barometer ranging lower than that at Somerset House by 016 in. the latter being about 95 feet above the Mean level of the sea at the coast; which, on the supposition of an agreement in the two Barometers between themselves, would give to Ackworth School an additional elevation of only 14 feet, making it 109 feet above the sea. But I find by trial, under very favourable circumstances of weather, that the site of my house, (which we esteem nearly on a level with the School,) is 105 feet, by the Barometer, higher than the level of the Calder, below the town of Wakefield: and there is I understand, between the latter level and the sea, very nearly 100 feet of lockage. Then 109+99-95=113. And the difference for 0.10 in. in the Barometer at 29.6 in. being 88 feet - 88 : 0.10 :: 113 : 0.128 in. But the difference being already 0.016, then 0.128-0.016=0.112. Thus the correction is made, in round numbers and as an, approximation, 11 hundredths of an inch to be added to the Ackworth Results, in order that they may agree with the London.

YEARLY RANGE AND EXTREMES OF THE BAROMETER
AT LONDON, &c. CONTINUED.

In the General Tables, C2, C3, are exhibited the greatest and least heights of the Barometer in each Month for two periods, of fifteen and seventeen years respectively: the former by the Wheel Barometer at the Laboratory, the latter by the Clock. The Clock Barometer stood in my house at Tottenham Green till the Third Month, 1828, when I removed it to my present residence at Ackworth.

The **Maxima** and **Minima** for the year are distinguished in these Tables by the same marks as in Table C: and the same rule holds generally here also, as to the connexion of the former with Northerly, and the latter with Southerly winds. In 1823, however, the Barometer was at its highest point for the year with an East wind, and at its lowest with a North East: and in 1827, it stood both at the highest and the lowest for the year with a South-West wind. The Yearly **Maxima** are still found mostly in the first three Months, and the **Minima** in the latter three; but there are now only three months out of the twelve in which, in seventeen years, neither extreme of the year is found.

The following Table, drawn from the Results contained in C3, when compared with the Table in page 39, will serve to exemplify the near agreement of the Averages of these two sets of Observations. The former were by the **Wheel** Barometer — these are by the **Clock**.

Year	Mean of 12 greatest elevations	Mean of 12 greatest depressions	Medium of the two former	Highest Obs. Of the Year.	Lowest Obs. Of the Year.	Medium height for the Year.	Annual Range.
1815**a**.	30.251	29.009	29.630	30.49	28.66	29.575	1.83
1816**b**.	30.259	28.844	29.551	30.55	28.43	29.490	2.12
1817**c.**	30.251	28.959	29.605	30.47	28.33	29.400	2.14
1818	30.358	29.168	29.763	30.60	28.35	29.475	2.25
1819	30.266	29.268	29.767	30.50	28.89	29.695	1.61
1820	30.397	29.145	29.771	30.70	28.52	29.610	2.18
1821	30.375	28.958	29.666	30.80	27.80	29.300	3.00
1822	30.341	29.168	29.754	30.70	28.82	29.760	1.88
1823	30.341	28.922	29.631	30.60	28.45	29.575	2.15
1824	30.433	29.027	29 730	30.68	28.30	29.490	2.38
1825	30.512	29.206	29.859	30.82	28.70	29.760	2.12
1826	30.491	29.400	29.945	30.70	28.80	29 750	1.96
1827	30.482	29.218	29.850	30.80	28.72	29.760	2.08
1828**d.**	30.456	29.028	29.742	30.58	28.92	29.750	1.66
1829**e.**	30.368	29.019	29.693	30.41	28.50	29.455	1.91
1830**f.**	30.231	28.949	29.590	30.42	28.58	29.500	1.84
1831**g**.	30.243	28.987	29.615	30.44	28.26	29.350	2.18
1832							
1833							
	Averages of seven years 1817-23.						
	30.333	29.083	29.708	30.624	28.451	29.545	2.17
	Averages of seventeen years 1815-31.						
	30.356	29.075	29.715	30.603	28.531	29.570	2.07

a. b. c. These are corrected, except in the Yearly Range, by taking off a tenth of an inch from the Results, the Scale having been placed too low by that quantity.
d, e, f, g. These are lower by what difference may result from the greater elevation of Ackworth above the sea, and for which no correction has been applied.

The most striking fact, to a common observer, in perusing this Table, will probably be the **great extent of range of the Barometer in the year** 1821: which was such as would justify an extension of the Scale, in Instruments destined to be used at some elevation above the level of the sea, to the point of 27 inches, downward: the higher extreme seems to have been fixed where it should be. The elevation of 30.80 in., one of the extreme points of the range for 1821, has been attained thrice in the course of seventeen years. With regard to the singular depression to 27.80 in., I need not do more, here, than refer to the Notes under Table CLXXXVII in Vol. III where it occurs, and is treated of; and to Table CLXXVII where will be found a remarkable elevation, which this depression seems to have served to compensate.

The **Mean Range** continues so nearly at **two inches**, that this quantity may now be taken as representing it in a round number.

The small differences in the averages at the foot of this Table, from those of the Table in page 39, will be found such as might be expected from an instrument which shows at all times the extreme variation. The Mean of the greatest Monthly elevations rises a little higher, and that of the depressions descends a tenth lower, bringing down with it the **Medium** from 29.746 to 29.70 in. on which point I shall presently add some remarks.

MONTHLY RANGE AND EXTREMES OF THE BAROMETER
AT LONDON, &c. CONTINUED.

The following averages, drawn from the Table C3, may be regarded as a continuation of this part of the subject; and it will at once appear, that in reducing them to a set of curves, on the same plan as the former, I have not been bestowing on them a useless labour. Compare Fig. 18 with 16, and Fig. 19 with 17. The observations were by the Clock Barometer.

FIG. 18.

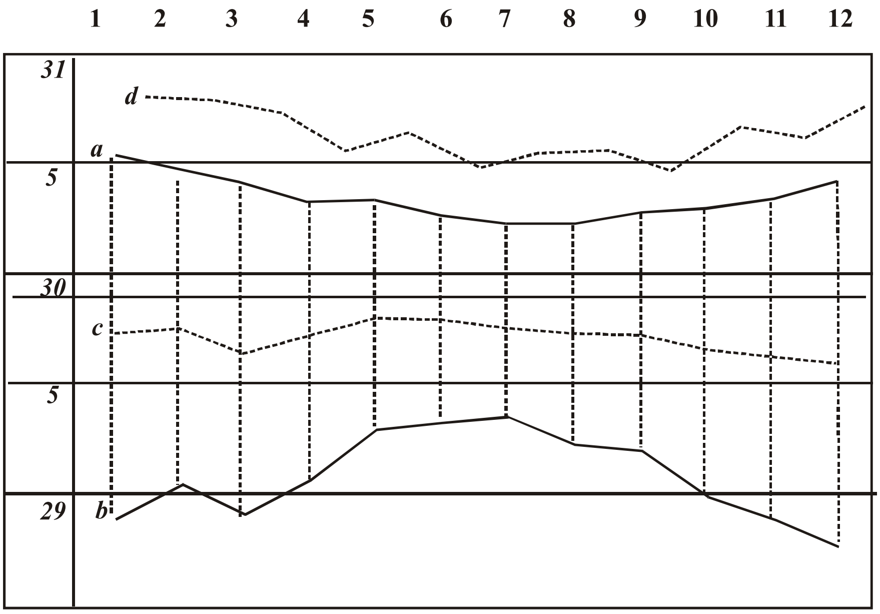
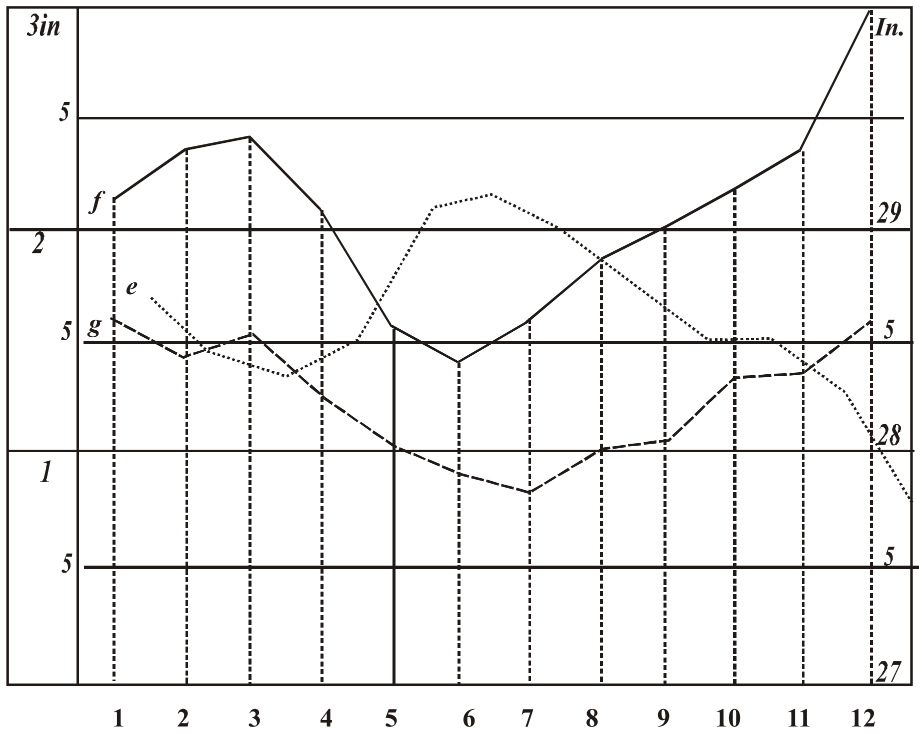


FIG. 19.



Month		Average of Maxima	Average of Minima	Difference or MeanRange	Greatest elevation in17 years	Greatest depression in 17 years	Difference or full range
1	Jan.	30.515	28.937	1.578	30.82	28.69	2.13
2	Feb.	30.459	29.024	1.435	30.80	28.45	2.35
3	Mar.	30.417	28.895	1.522	30.75	28.35	2.40
4	Apr.	30.330	29.042	1.288	30.57	28.50	2.07
5	May	30.307	29.262	1.045	30.61	29.06	1.55
6	June	30.282	29.335	0.947	30.54	29.12	1.42
7	July	30.216	29.375	0.841	30.57	28.99	1.58
8	Aug.	30.262	29.235	1.027	30.57	28.75	1.82
9	Sept.	30.292	29.207	1.085	30.50	28.52	1.98
10	Oct.	30.346	29.009	1.337	30.67	28.52	2.15
11	Nov.	30.377	28.970	1.407	30.65	28.30	2.35
12	Dec.	30.449	28.820	1.629	30.80	27.80	3.00

I proposed in the former Edition of this work, to remove the marks "Fair," "Changeable," "Rain," &c. from the parts of the scale to which they are at present found attached, and place them anew more fitly, with some reference also to the elevation above the sea at which the Barometer is to be used. It is clear that, **at the level of the sea**, the height of 29.80 will more truly represent the Medium, or the limit of fair and wet weather, than 29.50, at present marked changeable. As a proposition in round numbers, let us suppose a Barometer intended for use at from one to two hundred feet **above that level**, to be marked changeable at 29.70, and so in proportion lower for greater heights, up to 600 feet, where **this** mark would be at 29.30 in.; the others, which are of less consequence, being placed at their proportionate distances above and below it. I say these are of minor consequence, because I believe that in employing this Instrument as a weather-glass, it is needful to the success of the observer to attend to it daily, and to watch the approach of the quicksilver to the **true limit of the fair and wet indications**, and its receding from this in ascent or descent; with attention to past as well as present appearances. Fair weather and sunshine may often be found to accompany a low state of the Barometer; but they are not in that case to be depended on. Continued movements in either direction, may be safely taken as indicative of a corresponding duration in the weather they imply; and when the quicksilver in its downward course has passed the true changeable point, Rain, (if it have not fallen already,) is to be expected **in its rising again above it**; after which the fair weather indicated by that rise is found to obtain. The most difficult weather of all for the husbandman, when his labours require a certain degree and continuance of dryness, is that in which the quicksilver makes frequent short movements, in ascent and descent, still keeping **about** the point which answers to the limit above mentioned; **and which point it is therefore of consequence to settle accurately for him**, according to the elevation at which he is placed above the sea.

In taking out a Medium height, to serve for a standard, in comparing together observations with the Barometer, (where two numbers are added together and the sum halved for the result) we shall always find the result higher, as the number of observations is greater that enter into the sums used for the operation. Thus the extremes of seventeen years, in Table C3, 30.82 and 27.80 in. give us the medium height 29.31 in.: but take the **average** of seventeen years' Extremes, and the medium rises to 29.57 in. as seen in the Table, page 44. Again, let twelve Monthly Extremes be first averaged for each point, and these again upon the years, and we have 29.715 in. yet is this more than a tenth below the true **Mean** for London, which would be the result of the above operation performed on the whole of the daily Maxima and Minima for the period. The reason of this gradation is found in the great superiority in number of the **higher** daily, or other, observations over the lower; which, occurring more rarely, make up in extent what they want in frequency.

OF THE WINDS

THE direction in which the wind at any time passes over us, is far from constituting the whole of what we would wish to know on this subject. The length and breadth of the stream, its mean depth and velocity; the part of it in which we are at any time situate; the place where it took its origin, and that in which it wheels about to assume a new direction, or having spent its force, becomes stagnant; all these are objects of reasonable curiosity, which might perhaps be ascertained by distant and well-concerted observations. At present, we are able to infer only now and then a consequence, from the comparison of results found at home with those deducible from other registers, or from the reports obtained from the coasts by mercantile men; who are sometimes deeply interested in the cessation or continuance of particular winds.

The **Yearly** and **Monthly** results of the observations contained in the second volume of this work, will constitute the matter of the present section. In digesting these, I have assumed **five** classes for the winds. The observations would have furnished **nine**, but with limits less entitled to confidence than those which we obtain by embracing a greater number of points, and thus giving a chance of mutual compensation to some inaccuracies, inseparable from the smaller divisions.

1. The First Class extends from **North** to East, and not including the latter point; that is, it consists of my N and NE observations: and so of the rest.
2. The Second Class extends from **East** to South, not including the latter.
3. The Third Class from **South** to West, the latter not included.
4. The Fourth Class from **West** to North, (not included,) completing the compass.
5. The Fifth Class comprehends the **variable** observations.

YEARLY PROPORTIONS OF THE SEVERAL WINDS IN TEN YEARS.

The following Table contains a statement of these on the plan which I have described, the few days wanting in my Tables being supplied, for the purpose of calculation, from the Register of the Royal Society.

Year	N-E	E-S	S-W	W-N	Var.
1807	69	34	113	114	35
1808	82	38	103	103	35
1809	68	50	123	91	33
1810	81	72	78	83	51
1811	58	59	119	93	36
1812	82	66	93	91	34
1813	76	53	92	124	20
1814	96	65	91	96	17
1815	68	36	121	107	33
1816	64	66	106	102	30
Averages	74.4	53.9	104.4	100.4	32.4

This Table shows that, with some variation in different years, there obtains a proportion between the different classes of winds in our climate, which may be thus stated.

1. A wind from the North, or between that and the East, prevails on an average 74 out of 365 days: the greatest amount of its number being 96, the least 58 days.
2. A wind from East to South, 54 days, varying in different years from 72 to 34 days.
3. A wind from South to West, 104 days, varying from 123 to 78 days.
4. A wind from West to North, 100 days, varying from 124 to 83 days.
5. Variable winds obtain about 33 days, or the remainder of the year, their number being from 51 to 17 days.

The last mentioned division, from the arbitrary manner of noting, is probably the least exact in its limits: there being undoubtedly many days on which the observation might have been carried to one of the four classes, as **prevalent**; and others, on which the term **variable** might have been applied, in preference to the denomination set down. Yet amidst this uncertainty it is worthy of remark, that in **seven** out of the ten years its proportion varies only from 30 to 36, which would induce the conclusion that, were the observations uniformly attended to in this respect, the days on which the wind changes with some force **to an opposite point in the course of the day**, would be found between those limits.

If we now make of the whole two great divisions, towards East and West, allotting the variable to each in due proportion, we shall have

Easterly winds	…………	140
Westerly	…………	225
		365
If towards North and South, then		
Northerly winds	…………	192
Southerly	…………	173
		365

Thus a Westerly direction is found to preponderate by about a **third** over the Easterly; and a Northerly direction by about a **ninth** over the Southerly, in the winds of these ten years.

I suppose that a careful revision of the observations, with the aid which might be got from other registers, would introduce some corrections, but probably not any alterations of moment, into these averages. A different series of years in the same district of the island, or the same series in a different district, might also give same variation in the results. The reader is therefore to be on his guard against applying them **generally**, at least for the present. I have no comparative results to introduce on this occasion.

MONTHLY PROPORTIONS OF THE
DIFFERENT WINDS FOR TEN YEARS.

The following Table exhibits these in days and decimal parts, the classes being as before, and the term from 1807 to 1816.

Month		N-E	E-S	S-W	W-N	Var.
1	Jan.	6.8	5.3	7.0	9.1	2.8
2	Feb.	3.2	4.0	11.7	7.4	1.7
3	Mar.	9.8	5.4	6.6	6.5	2.7
4	Apr.	8.3	5.6	6.0	6.4	3.7
5	May	5.9	6.5	9.0	5.6	4.0
6	June	7.1	3.0	7.2	9.1	3.6
7	July	4.5	2.5	9.5	11.5	3.0
8	Aug.	3.5	2.9	10.2	12.9	1.5
9	Sept.	6.4	6.0	8.0	7.4	2.2
10	Oct.	5.2	5.0	10.5	7.4	2.9
11	Nov.	7.8	3.1	8.8	8.4	1.9
12	Dec.	5.0	4.6	9.9	9.7	1.8
Averages		6.00	4.50	8.70	8.45	2.65

In the **First Month**, which may be regarded as the middle of winter, we have little more than a mean proportion of N-E winds: yet the **Northerly**, taken together, preponderate by a **fourth** of their amount over the Southerly winds.

In the **Second Month**, the proportions of Northerly and Southerly are reversed, the latter exceeding the former by a **third**; and this principally through the falling off of the N-E to one half, and the increase of the S-W to their highest proportion for the year.

In the **Third Month**, the N-E are in greater proportion than in any other part of the year, exceeding their own average by more than a third.

In the **Fourth Month**, the N-E winds abate somewhat of their excess, continuing still in very high proportion. This and the preceding month exhibit about the same total preponderance of Northerly winds, as the First month: and in both, the E-S class being above its average, the general Easterly direction prevails over the Westerly.

In the **Fifth Month**, the Southerly winds resume the like superiority as in the Second. The E-S class is at its maximum. The N-E having decreased for two months, is now below its average: and the W-N which has decreased by an uninterrupted gradation from the First month, is at its **minimum** proportion: the **variable** winds are at their highest amount.

Sixth Month: a preponderance of **Northerly** winds by more than a **third**; chiefly from the return of the W-N class.

Seventh Month. In this month, the class of W-N decidedly prevails over the rest: the S-W is also in high proportion: the N-E very low, and the E-S at its **minimum**, having gone off for two months.

The **Eighth Month** exhibits the class N-E at its **minimum**, and that of E-S but little removed from it: while the W-N is at its **maximum**, having increased for three months, and the S-W in high proportion, having increased for two months. This month has the least proportion of variable winds.

Ninth Month. We have here almost a balance between the Northerly and Southerly winds. In other respects the class E-S, (which we must remember comprehends the former **point** and excludes the latter), takes a little from the rest, and is but little short of its highest amount.

In the **Tenth Month**, the winds on the North and South sides of East are very nearly equal: but the S-W class predominates over the whole, and with the aid of the E-S, exceeds the Northerly winds by a fourth of the sum of the latter.

Eleventh Month. Northerly winds now predominate by a fourth of their amount; chiefly from the increase of the class N-E; and the proportion of **variable** is very small.

Twelfth Month. The classes in this month do not depart very far from their respective averages. We have again the Northerly and Southerly almost exactly balanced; while the Westerly are nearly double the sum of the Easterly.

The monthly proportions of the several classes **in each year**, will be found in the general Table D, over the monthly amounts of rain. I shall have occasion to resume the subject more than once, in the course of this volume, with a view to the connexion of particular winds with the variations of the Barometer, or with dry and wet seasons; and their relation to the Lunar periods, the Solstices, and the Equinoxes; but it was proper first to present the reader with the immediate Results of the Register through its several divisions.

The subject of the Winds is one of so great interest to the community, that nothing but the apparent want of system, in their variations in these latitudes, can have prevented men of science from studying them with greater attention, and bringing out some useful results. I believe the experience of our navigators, in this as in some other respects, outruns science, and furnishes already some general axioms, respecting the Winds commonly met with at particular seasons in our climate. It would be rendering no small service to those who have frequent occasion to quit our coast, or to enter our harbours from the seas, could the whole of the information already within our reach on this subject be digested in a systematic form for their use: more especially, as it might enable them to anticipate with greater certainty the recurrence of those long periods of NE, and SW winds, not improperly termed the Monsoons of our climate, by which our communication with the Atlantic is at times impeded, at others facilitated, for whole months together.

YEARLY PROPORTIONS OF THE SEVERAL CLASSES OF WIND IN SEVEN YEARS.

l have calculated the proportions of the several classes of winds in the **Septenary**, which are here added: so that the reader, with the help of the remarks attached to the Table of the **Decade**, in p.49, may perceive the general agreement, and the few differences in particulars, of the two, respecting which I shall not say any thing more at present.

Year	N-E	E-S	S-W	W-N	Var.
1817	77	47	113	99	29
1818	65	77	109	82	32
1819	79	55	94	126	11
1820	84	57	90	117	18
1821	61	60	105	127	12
1822	82	58	110	106	9
1823	67	57	103	130	8
Averages	73.6	58.7	103.4	112.4	17

MONTHLY PROPORTIONS OF THE SEVERAL CLASSES
OF WINDS IN SEVEN YEARS.

The like comparison may here be made between the **Decade**, presented at p.49, and the **Septenary** extending from 1817 to 1823, which follows.

Month		N-E	E-S	S-W	W-N	Var.
1	Jan.	4.3	6.0	10.0	8.3	2.4
2	Feb.	4.3	3.6	7.9	9.9	2.3
3	Mar.	5.0	3.0	9.6	11.6	1.8
4	Apr.	8.0	6.7	6.0	7.7	1.6
5	May	8.7	6.1	8.2	7.0	1.0
6	June	7.3	4.1	7.1	10.2	1.3
7	July	5.0	3.0	9.0	12.0	2.0
8	Aug.	6.1	3.0	8.5	13.0	0.4
9	Sept.	7.7	5.0	6.3	9.7	1.3
10	Oct.	6.9	6.7	9.3	7.6	0.5
11	Nov.	4.0	6.0	11.0	8.0	1.0
12	Dec.	6.3	5.6	9.7	8.1	1.3
Averages		6,14	4.90	8.50	9.45	1.41

The general Tables D, and D2, from which these results are taken, may be consulted for a more minute inspection. I have not extended the statement beyond 1823, because the **Decade** is not complete until the year 1833 shall have expired. The present materials may enable the reader to decide for himself in what degree my former conclusions are established by the comparison, in this department also, with more recent observations.

OF THE EVAPORATION

Experiments made with a view to ascertain the natural Evaporation differ in their results according to the manner in which the water is exposed. If it be fully acted upon by the sun and wind, in a vessel of small capacity, the quantity evaporated appears in excess: if greatly sheltered from both, the contrary. In the whole of the experiments detailed in the Second volume, the water was placed under cover; just sufficiently sheltered to prevent the entrance of driving rains, and consequently the direct impulse of the sun's rays when much elevated above the horizon. During the first three years, the results were entered almost daily in the Tables: afterwards, at intervals varying from two to ten days, or weekly. But in the year 1815, having substituted for these results the daily indications of the Hygrometer, I ceased to attend so constantly to the Evaporation.

MEAN EVAPORATION IN THE YEAR

In the years 1807, 1808, and 1809, the gauge being elevated about 43 feet from the ground, exposed to the SE, and subject to the free action of the wind in most directions, the annual average result was 37.85 inches.

From 1810 to 1812 inclusive, the instrument being in various situations, for the most part lower and less exposed, the annual average was 33.37 inches.

Lastly, in the space from 1813 to 1815 inclusive, the gauge being upon or near the ground, the annual results averaged only 20.28 inches.

Having resumed in 1818 the observations conducted on the ground, I obtained in eleven months a total of about 23 inches; to which if we add a mean result for the month omitted, we shall have for this year (so remarkable for its hot and dry summer) an Evaporation of nearly **twenty-five** inches: a quantity not disproportionate to the average of the three years last recited, considering that the calmness of the air during this summer was as remarkable as its high temperature.

The Evaporation obtained in 1818 very nearly equals the annual average depth of rain about London. In years with a cool or wet summer it falls below this standard: but on account of the acceleration to which this process is liable by the effect of strong winds, it is difficult to make an accurate comparison in two seasons of unequal temperature. Nor is it likely that with a little water, exposed in a vessel of a few inches diameter, we should obtain a complete solution of this problem, as it is set before us on the great scale of nature. The first or second of the three averages above stated may perhaps approximate to the Evaporation from our rivers, the surface of which is always in motion by the winds and currents: the third may be considered as representing that of small canals, ponds, and reservoirs.

EVAPORATION IN THE DIFFERENT SEASONS OF THE YEAR.

The Monthly results which form the basis of this section are digested in the general Table E, at the end of the volume. The series (of eight years and a half) is an interrupted one, but it presents at least seven results for constructing each of the monthly averages at the foot of the Table. These averages run, as might have been expected, with a general, but not uniform, relation to the Monthly Mean temperature. The cause of Evaporation is the heat contained in the fluid, and it has been long since shown that, other things being equal, the effect is in relative proportion to the temperature. But in nature it is always modified by the quantity of vapour already subsisting in the atmosphere, considered relatively to the temperature of the latter. For instance, in the Third month 1807, the mean temperature of which was 42°, the Evaporation amounted to 2.66 in.: but in the Tenth month of the same year, with a temperature somewhat exceeding 42°, and more wind, it was only 1.86 in.: the difference being plainly caused by the autumnal season.

If we take the Twelfth, First, and Second months as the Winter, and the remaining months in similar classes of three, for the other seasons, and divide the average Evaporation among the four classes, it will stand thus:

		Evaporation	Mean Temp.
Winter	………..	3.587	37.20
Spring	………..	8.856	48.06
Summer	………..	11.580	60.80
Autumn	………..	6.444	49.13

I have added the mean Temperature for each season as thus divided, the total of degrees of mean Temperature being 195.19, and that of mean Evaporation 30.467 for the year.

Then 195.19 :	30.467 : :	37.20 :	5.806
195.19 :	30.467 : :	48.06 :	7.501
195.19 :	30.467 : :	60.80 :	9.490
195.19 :	30.467 : :	49.13 :	7.668

The four results thus brought out being the quantities which ought to have been raised in vapour in each season, had the effect been in strict proportion to the Temperature, it follows that in the three months here taken as **Spring** the Evaporation is **augmented** by about a sixth part, and in those taken as **Summer** above one fourth part, in consequence of the **dryness** of the air in these seasons: while in the three months taken as **Autumn** it is **lessened** by more than a sixth, and in those taken as **Winter** by considerably more than a third, in consequence of the **dampness** of the air.

To examine more particularly the monthly results — we see that, as the Temperature advances in the fore part of the year, the Evaporation on the whole increases steadily; but in particular years it receives a check in some part of the spring, which is afterwards made up by a sudden increase. The reason of this is sometimes obvious in the variations of Temperature; as in the year 1809, where I have annexed the mean Temperatures to the results. The rate is likewise occasionally kept down in this part of the year (as in the latter months) by frosty weather. The very great increase in a fine spring may possibly be due, in part, to the electric state of the air in such seasons. For although Electricity, in the low degree in which it is applied by nature at the Earth's surface, may not sensibly promote the actual emission of vapour from water, it may tend greatly to increase the retentive power of the air, by rendering the particles of the mixture of gases and water in a higher degree mutually repulsive, or in other words, by keeping up the **elasticity** of the atmosphere.

I have attributed an occasional low rate of Evaporation in Spring to the state of the Temperature. Without destroying this position, we may however invert the terms, and say that it is then even colder **because of the evaporation**. It cannot be doubted that the **sharpness** of our NE breezes in Spring is in measure the result of their excessive dryness, relatively to the Temperature which prevails: in consequence of which they abstract the heat from the animal system by means of the moisture on the skin, which they convert with peculiar rapidity into vapour.

In the latter part of Spring the **gauge** sometimes indicates an abundant supply of vapour, when in fact very little is poured into the atmosphere from the Earth; the surface, and even some considerable depth under it, being already dried by the sun and wind. It is then that we perceive the effects of the natural irrigation, carried on by means of the vapour diffused in the day-time from canals, rivers, &c. and condensed by night in copious dews, which descend on the neighbouring herbage. Should the season afterwards prove showery, a great quantity of the first water that falls is vapourised by the heated Earth, with a rapidity of which, again, the **gauge** gives no proper indication. This vapour may even continue to be thrown up, after the air has begun to approach towards saturation, and thus contribute to the formation of the next rain. And the water may be thus driven from the Earth to the clouds, and returned again in rain, until the surface, being cooled down, is prepared for desiccation under the solar rays by a drier current. The sudden change from a dry to an extremely humid state of the air, immediately after our Spring and Summer showers, is often sufficiently obvious to be detected by the most superficial observer: it is generally due to this sudden and copious production of vapour at the surface. The Spring and Summer are our most variable seasons in point of hygroscopic dryness.

In the Autumn, or rather at the approach of Winter, the rate of the production of vapour declines with great rapidity. The commencement of a saturated state of the air, while as yet precipitation has not generally commenced, gives to our fine autumnal weather a delicious **softness**, the reverse and the compensation of those keen blasts which so often attend the vernal season.

But this state does not continue long. On the approach of the first frost — indeed during a great part of our ordinary winters, the earth and waters retaining a temperature somewhat above that of the air, continue by the force of this inherent warmth to emit vapour. This is continually undergoing decomposition, and it fills the air with a **mist**, which, when by no means dense enough to constitute what we call **fog**, would yet appear to an observer stationed above its limits, as a white veil thrown over the whole face of the country: thicker indeed in the valleys and along the course of the rivers, but nowhere in our district surmounted by the land.

EVAPORATION UNDER DIFFERENT CIRCUMSTANCES OF WIND, TEMPERATURE, &c.

There are few **days** in the whole year in which some vapour is not raised from the gauge: but the process is apparently suspended while **dew** falls by night. A state of the air analogous to this appears to be the cause of its complete interruption by day: of which the reader will find some instances in the Tables, chiefly in the vicinity of the Winter solstice, and at the approach of frost.

It is not always suspended during **rain**, as I have ascertained by direct experiment. The rate is however usually much less on those days in which rain falls, and it is liable to a rapid increase immediately afterwards.

Sometimes, an excess in the rate is found to **precede** rain, whether from the agitation of the air, or the effects of electricity, or from both causes, I have not attempted to determine.

The calm which attends a change of wind sensibly lowers the rate: which also decreases, as might be expected, upon the going off of a wind which has blown steadily for some days.

A moist current of air flowing in upon us will sometimes check the Evaporation, although rain be not produced from it.

Examples of the gradual increase of the rate of Evaporation, in consequence of an elevation of the daily Temperature, and its decrease by the contrary, as likewise of the variations to which it is subject in windy weather, are so numerous in the Tables that it is needless to instance them.

GREATEST AND LEAST
MONTHLY AND DAILY EVAPORATION.

The greatest Evaporation in a month **by the higher gauge**, was about 6 inches: in this case a number of favourable circumstances appeared to concur: a high Spring Temperature succeeding to protracted cold; dry winds and an abundant electricity.

The smallest Monthly results are found at the approach and during the continuance of the great frost of 1813-14. And here we have a striking example of the retarding effect of a moist air on the process. In the last month of 1813, with great **fogs** prevailing, the mean Temperature being 38°43, the Evaporation was 0.21 in. (in all probability the lowest amount in ten years,) but in the first three months of 1814, the frost having set in with rigour, and cleared the air, we have a gradation of increasing results thus, 0.25, 0.36, 0.83 in. with the mean Temperatures 26°71, 33°17, and 37°82, all inferior to the former, and the first of them almost 12° below it: which difference in the effect is plainly due to the extreme dryness of the currents prevailing in the latter period.

Indeed, the most intense **cold** is insufficient of itself to put a stop to the formation of vapour. Ice evaporates freely during a clear frosty night; as I have repeatedly convinced myself by direct experiment: see Tables XXVIII, XC, XCV, of the Vol. II. In the former of these experiments, a circular area, five inches in diameter, lost 150 grains between sunset and sunrise. This is at the rate of more than 8000 Troy pounds of ice, or near 1000 gallons of water, from an acre of surface, in that time. The absorption of heat, necessary to the composition of so much vapour within a small space of the atmosphere, must be prodigious. In one instance of this kind, I found the depression of Temperature to exceed 10 degrees: the Thermometer on the snow being at 6°5, while that at five feet elevation was at 17°. Some part of this cold, however, might be ascribed to the radiation from the surface of the snow.

With these facts before us, we need not wonder to hear that a moderate fall of snow is sometimes entirely taken up again, during a succeeding Northerly gale, without the least sign of liquefaction on the surface. In deeper snows, the surface after a while becomes curiously grooved, scooped, and channelled, from the same cause: which effect is most conspicuous around the trunks of trees, and near the interstices of paling, — in short, wherever the stream of air acquires force in a particular direction. A little observation will satisfy any one that the snow is not removed, on these occasions, merely by being driven before the wind.

Consistently with these facts, a sensible change in the air to a dry state, after damp foggy weather in winter, may be always safely placed among the indications of approaching frost.

To return to some considerations connected with the higher extreme of Temperature — a rapid decrease of the daily Evaporation in hot weather may furnish a prognostic of approaching thunder and rain, very convenient to add to those we possess already. The greatest Evaporation in one day (a single instance excepted) which I have ever seen, occurred on the 17th of the Fifth month, May, 1809. On that day the amount was 0.39, on the following day 0.28, on the next 0.14 inches: the corresponding mean Temperatures being 67°, 70°5, and 64°, and consequently furnishing, in respect of heat, no adequate cause for the decrease. But in the evening of the 19th occurred that tremendous storm of hail, rain, and thunder, which I have particularly described under Table XXXII of the second volume: and I cannot help supposing that, on this occasion, the local influence of heat, aided by an electric charge in the air, had suddenly raised, as it were, a mound of vapour into those elevated regions, which it rarely visits in these latitudes, and where it is subject, from the contiguity of an intensely cold medium, to complete and extensive decomposition; in which seems to lie the true cause of the prodigious development of electricity manifested on those occasions. In the same Table the reader will find a decrease of the daily Evaporation in this ratio, 0.33, 0.26, 0.19 followed by a tempest of wind, and a week's wet weather: but in this case the Barometer, Temperature, and Sky, furnished concurrent indications.

The going off of the excessive heat in the Seventh month, 1808, of which I have already treated, in stating the Extremes of the Climate, under the head **Temperature**, was attended at Plaistow (although the reaction in the atmosphere took place about Gloucester) with the following rapid decrease in the daily rate of evaporation. The hottest day being 0.35, the four following were 0.31, 0.27, 0.20, 0.16 inches: and this without more than a few drops of rain in our own immediate neighbourhood. The Notes and appended Extracts from different publications, in Volumes ii. and iii., will be found to present some curious instances of excessive Evaporation, connected with peculiar localities and seasons, to which I need not here refer particularly.

OF THE MOISTURE BY THE HYGROMETER

WHILE the Evaporation Gauge indicates the rate of the production of vapour from surfaces capable of affording it to the air, the Hygrometer informs us of the state of the latter as approaching more or less towards a relative maximum of moisture; the existence of which, whether in higher or lower atmosphere, is commonly followed by rain.

At elevations of a few feet, the Index of the Hygrometer is usually found at sunrise on the moist side of the Mean of the season. As the sun advances, in a fine morning, it recedes towards the dry side, sometimes with considerable rapidity, passing through twenty degrees of the scale by noon. In the evening, if not earlier, it returns again towards moisture. To obtain a true **Mean** of variations so considerable, it would be needful to take a number of observations at equal intervals through the twenty-four hours, and average them. But I am not aware that any observer has yet gone so far as to obtain the extremes indicated in that period, in order to record a daily **Medium**. In fact, the present observations have the same disadvantage as would attend those on Temperature, were the Thermometer inspected but once in the day, at a fixed hour. The time which mere convenience induced me to adopt is nine in the morning. About the Equinoxes, this hour is a medium between sunrise and noon, and consequently a very fit time to obtain a mean result. But in winter it approaches too near to sunrise, and in summer recedes too far from it. Imperfect as my results are, on this and other accounts, they are yet too valuable to be passed over, and I shall here give a summary of them with some remarks.

MONTHLY MEAN OF DE LUC'S HYGROMETER FOR FOUR YEARS,
FROM DAILY OBSERVATIONS MADE AT 9 IN THE MORNING.

		1815	1816	1817	1818	1819	Averages
1	Jan.		81	80	78	81	80
2	Feb.		78	67	81	75	75
3	Mar.		67	64	65	71	67
4	Apr.		59	52	61	69	60
5	May		†57	52	†57	64	57
6	June		†49	47	†47	66	52
7	July			47	45	63	52
8	Aug.	†50		52	†47	59	52
9	Sept.	†61	64	58	†66	71	64
10	Oct.	73	78	†59	73		71
11	Nov.	79	84	†76	81		80
12	Dec.	79	83	78	80		80

The results marked † are the mean of a deficient number of daily observations, varying from thirteen to twenty-five days in the month.

The **general mean** of these observations is 66: and the state of moisture about the Equinoxes, it will be observed, approaches near to the mean, the average of the Third month being one degree moister, and that of the Ninth two degrees drier.

The extreme Monthly averages are 80 for Winter, and 52 for Summer; which points are equidistant from the general mean. In the Spring and Autumn, the averages exhibit a gradation from each of these points to the other. It is obvious, that had the observations been made always at noon, the Medium and Extremes would have been respectively, and perhaps proportionately, nearer to dryness: had they been made always at an hour equidistant between sunrise and noon, the two extremes would have approximated nearer to the medium. As it is, they mark strongly the character of the respective seasons of our climate in point, of moisture or dryness; and those of our medical practitioners who at present attend to the Thermometer, as an assistant to their judgment in anticipating the prevailing diseases of the season, will perhaps be able, with the help of some such standard as this Table, to avail themselves of the Hygrometer also, for the like laudable purpose.

CONNEXION OF THE MOVEMENTS OF THE HYGROMETER WITH EVAPORATION AND RAIN.

In general, a comparative degree of dryness by the Hygrometer is connected with Evaporation and fair weather; and of moisture, with precipitation and rain; regard being had, in both cases, to the **mean** of the season. During the Lunar period, commencing with the 8th of the Fourth month 1817 (Tab. CXXX), there fell only 0.28 inches of rain: the Hygrometer at nine a.m. was never beyond 63, and once at 34, the mean of the period 49. In the next Lunar period, there fell 3.18 inches, during which the Hygrometer was once at 80, and the mean of the period was 54.

But there are exceptions to be noticed here. In Summer, when precipitation is actually going on above, and thunder-clouds are already formed, the air below may continue, from the intense heat and the arid state of the soil, hygroscopically dry. An instance of this occurs presently after the above, in Tab. CXXXII, Sixth month 24, Hygrometer at nine, 47, (the mean of the period,) "Morning cloudy, then fine: in the evening heavy rain, with hail, thunder, and lightning: Hygrometer before the storm, 36." Next morning at nine it was 61, the rain having afforded vapour: but dry indications again came on, followed by other thunder-storms, to the close of the period, which afforded 2.81 inches of rain.

In Winter, on the contrary, the air is sometimes very moist for a considerable time, without rain: chiefly during the prevalence of foggy days and frosty nights, with a high Barometer: for an instance of which see a space of more than two weeks, following the Winter Solstice, 1818, (Tab. CLI). In clear sunny days of frost, however severe, it is otherwise: the hygrometer indicated several times a dryness of 46 to 50 in the middle of the day, during the intense cold in the Second month 1816. See Tab. CXV, which also presents some examples of the moist extreme, followed by snow. In Tables CXXIV, CXXV, CXXVI, (in the Autumn and Winter of 1816) will be found a number of examples of hibernal moisture, some with, and others without the accompaniment of rain. For an example of Summer moisture brought on by the fall of rain, it may suffice to point out Tab. CXLV, Seventh month 12; where the Hygrometer, having been for several mornings at 46 - 42, was brought at once by this cause to 70.

A rapid movement of the Index towards dry, in the morning, seems to indicate a fair day, notwithstanding unfavourable signs in other respects. See Tab. CXVI, Third month 16: also Tab. CX, Eighth month 29, consulting the Notes. But extreme and unusual dryness should be suspected: see the same Table, under Seventh month 14, when a kind of **Harmattan** seems to have been blowing, and the Index receded to 22, (the driest point at which I have seen it) yet rain followed in about 48 hours, though a very dry time before, and for some days after.

On the other hand, if the Index, when found on the moist side, in the morning after a fair day, continue stationary, or advance to a higher number, rain is to be expected; and this is perhaps among the most certain indications of such a change. See the same Table under Ninth month 24, 25, and consult the fore part of the following Table. See also Tab. CXLVII, Eighth month 27, and Ninth month 1, 4, 15, with the Notes. A change towards dryness **during rain or snow** is favourable, at whatever time it occurs. See Tab. CVII, Sixth month 14, the Note; and 126, Eleventh month 10, with the Note.

But the most valuable prognostics are afforded by a progress **from day to day** towards the moist extreme of the season. Numerous instances of this gradation occur in the course of the Tables: and it is observable, that a retrograde movement towards dryness often takes place during the wet or showery weather, which the preceding advance towards the moist extreme had prepared us to expect. It will suffice to bring the following cases in proof — Tab. CXXXVII, Eleventh month 27, to Tab.CXXXVIII, Twelfth month 19; and Tab. CXL, Second month 13, to the end.

Such are the results of the few observations which I have incidentally made on the movements of this instrument, in connexion with other indications: and they tend to show that a regular attention to it in this way would reward the pains of the observer. It would be necessary to complete success, to ascertain the mean proportion of the scale through which the Index **recedes**, in a given time after sunrise in each season: by comparing the daily quantity with which, a judgment might often be formed as to the proximity of rain. The more palpable sign of this, given by the advance towards moisture in the forenoon, would then likewise be frequently found useful.

OF THE DEW — OR VAPOUR-POINT.

I HAD given so little practical attention to this part of the subject of Hygrometry, that it would have been suffered to pass unnoticed here, but for the appearance of a new instrument, adapted to the more ready discovery of the vapour-point; and which has come under my notice only since the last section was finished at press.

The introduction of this process into Meteorology is due, in common with many other original ideas and operations, to my friend John Dalton. It consists essentially in ascertaining, by means of a cold body, the temperature at which the vapour diffused in the atmosphere will begin to be decomposed and to deposit its water. The familiar fact of the dew which, in certain seasons, immediately forms on the outside of a glass vessel, newly filled with water from a deep well, may serve to illustrate the process: the intention is, to discover the precise temperature at which a body will begin thus to elicit water from the air; and by comparing this with the temperature of the air, to judge of its approach towards saturation: it being manifest, from our knowledge of the superior attraction of the permanent gases for heat, that the moment the air itself shall arrive at the temperature indicated by the cold body, it will perform the same office — it will rob the vapour diffused in it of a portion of its constituent heat, and separate the water in **dew**, **mist**, or **rain**.

Only three experiments of this kind are recorded in my observations in the Second volume. In the first, Tab. I., I found the dew-point but one degree below the temperature of the air at noon. On that day there was no sensible evaporation by the gauge, and the rains, which had prevailed some time, continued for several days after. On the second occasion, Tab. LXVII., I found it at $2^{h.}$ $30^{m.}$ p.m. within 3° of the temperature of the air. "In an hour afterwards, it began to rain steadily, and there fell more than half an inch in depth." The third time, Tab. LXXXIII, "the air was so loaded with vapour at 9 p.m. as to deposit water on a glass vessel cooled to 58°, the lowest temperature of the following night being 53°. At this time it began to rain heavily, ceasing at 10, with thunder and lightning still in the North." In effect, during this and the four following days, there fell above two inches of rain.

The time and trouble required to perform the operation on purpose (for an accidental deposition on a glass has sometimes suggested the comparison of the temperatures) have prevented frequent experiments on my part. It is therefore with some satisfaction that I notice the introduction of **Daniell's Hygrometer**, of the construction and uses of which an ample account is given in the Quarterly Journal of the Royal Institution, No.16, together with a Meteorological Journal of four months, containing its indications, by the inventor.

In this instrument, the design of which appears to have been taken from the model of Leslie's Hygrometer and Wollaston's Cryophorus, the requisite degree of cold is produced at all times, with ease and certainty, by means of the evaporation of a few grains of ether. The ether being dropped on the surface of a hollow sphere of glass, covered with muslin, and full of the vapour of ether, an immediate condensation of the latter generates a vacuum within it: into this a second evaporation of ether instantly takes place from a second naked bulb partly filled with that liquid, and connected with the former by a tube. The cold thus produced in the second bulb, causes in a short time a visible deposition of dew from the air on its surface: the temperature at which this effect begins, is indicated by a small included thermometer; and a second thermometer, for the temperature of the atmosphere at the moment, is attached to the pillar which supports the bulbs and tube.

It is obvious that by such an instrument greater facility is afforded to the Meteorologist, of satisfying himself respecting the state of the vapour constantly diffused in the atmosphere, and of drawing from this, **in conjunction with other evidence**, a more certain prognostic, in critical seasons, of wet and dry weather. It is not likely, any more than the Barometer, always to answer this purpose when used **alone**, there being evidently other conditions necessary to the production of rain at a given station, besides the present saturation of the air immediately incumbent on it.

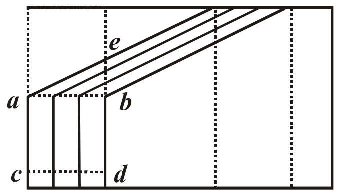
The constant, though minute, expenditure of ether for the experiment may prove to some observers an objection to its use. This may be in part obviated by using a bottle fitted with a tube ending in a capillary opening, and closed in the middle, or near the fine part of its bore, with a stop-cock, which would prevent any unnecessary waste of this volatile fluid; as the heat of the hand would suffice to expel a sufficient quantity upon the ball. It is also possible that some future improvement of the instrument may enable us to produce 20° of cold, which seems to be all that is wanted in the driest season, without the waste of any material at all. To those who may be occasionally engaged in experiments to find the force of vapour and quantity of moisture present in different seasons and places, and at different elevations in the atmosphere, I have no doubt that this elegant little instrument, which is portable (inclosed, in a mahogany box) in the pocket, will be a valuable acquisition.

OF THE RAIN

THE position or elevation of the gauge affects the product nearly as much, in the case of Rain, as in that of Evaporation, but in a different way. The Evaporation is increased, as has been shown, by elevating the gauge, but the product of Rain in this case is usually diminished: insomuch that when the gauge is transferred from the ground to the house-top, the average falls off by about a fourth part.

I have treated this subject under Table LXIV of my observations, where are detailed the results of experiments made during twenty successive days of wet weather, in the autumn of 1811, with a view especially to discover a rule for correcting former results; as also to ascertain the circumstances under which these differences take place. I have since seen no sufficient cause to abandon the conclusion I then came to; that, when Rain takes place with a turbid atmosphere, a considerable and variable proportion of the water is actually separated from the vaporous medium, at a height not exceeding 50 feet (or that at which my upper gauge was fixed, which was 43 feet) and that this portion, consequently must be deficient in the upper gauge. But in showers from an elevated region, falling through an air which is not itself undergoing decomposition, the products ought to be (as is the case in some instances) alike in both gauges.

In the reasoning connected with those experiments, I did not advert to a possible constant effect of the wind, in lessening the product of the gauge in this more exposed situation; but contented myself with proving by experiment "that rain may be drifted as well as snow;" or that a portion of the general receiving surface may be robbed of a part of its rain, by deflected currents in the moving atmosphere, which transfer it to another place; which it was shown happens especially where two gauges are placed, the one on the windward, the other on the leeward parapet of a building; the latter being redundant, while the former is deficient in product, the level considered. What proportion of the deficiency in product of a gauge placed on a building should be ascribed to this cause, it may be difficult, without experiments carefully made on the spot, in all cases to decide. It would undoubtedly vary, according to the position of the gauge, with respect to the wind by which the rain might be carried at the time. But the question of this difference has lately been discussed in the Journals, on principles purely mathematical. By some, and among them a meteorologist of note in France, **Flaugergues**, it has been attributed wholly to the effect of the wind, in giving an oblique direction to the streams of Rain; in consequence of which, it is contended, the funnel or mouth of the gauge, actually presents a smaller **aperture**, in proportion as the Rain comes more obliquely: just as if we were to incline the funnel to one side under a rain falling vertically; in which case it is manifest that less and less Rain would enter as it became more inclined, until in a perfectly horizontal position, the whole would pass by to the ground. But in reply to this, it is said, and I think very justly, by **Meickle**, (in Thomson's Annals for October 1819,) that in the case of Rain falling with a wind, 'the **horizontal** distance of the lines in which the rain falls is absolutely independent of their inclination, being accurately the same, where the wind runs steadily 60 miles an hour, as if it were a perfect calm.' 'In strictness (this writer further observes) **the drops fall in curves**,' but supposing them to pursue a right line 'it is plain, that a gauge of the width shown at **a b** will there receive the drops, falling obliquely, just the same as after they become perpendicular in the calm, at **c d**.' And it is equally obvious, from a comparison of the space **b-e** with the space **a-b**, that **of rain so deflected**, a gauge with its aperture inclined in a suitable direction, would receive **much more** than the quantity then actually falling on the general surface: consequently that, **with reference to this standard**, the aperture in the direction **a-b** would receive to little.



It appears therefore that no allowance is required, in any position of the gauge as to height, **for the simple obliquity of the whole body of a shower**; the rain received by the entire horizontal surface included in its area (and of which the mouth of the funnel may be considered as a definite part) being the same whether the descent be oblique or vertical.

MEAN ANNUAL DEPTH OF RAIN ABOUT LONDON

The Mean annual depth of Rain in our district is very nearly 25 inches. This being the largest average that has yet, so far as I know, been assigned to London, it will be proper to show the ground on which it rests.

On the evidence of the experiments in the autumn of 1811 already alluded to, I assume for the present, that the Rain on the ground is to that collected at 43 feet above it, as 37 to 28: but in what proportion the difference may increase with a greater elevation, I have not the means of deciding: it is probable that the deficiency at greater elevations would be found in a rapidly diminishing proportion to the height. The gauge of the Royal Society is stated to be 75 feet 6 inches above the surrounding ground. But so much of this surrounding ground is covered with buildings, that we may consider the **difference** between the two elevations as nearly done away in regard to practical effect, and I shall therefore neglect it.

ANNUAL RAIN FOR TWENTY-THREE YEARS

The following then is a statement of the annual Rain by the gauge of the Royal Society for ten years previous to my own account. In a second column I apply to these amounts the proportion of difference above assumed, to bring out an estimated result at the surface of the earth.

Year		Rain at 75 feet by observation		The same at the ground by estimate
1797	………..	22.697 in.	………..	29.996 in.
1798	………..	19.411	………..	25.650
1799	………..	19.662	………..	25.982
1800	………..	18.925	………..	25.008
1801	………..	19.197	………..	25.367
1802	………..	13.946	………..	18.428
1803	………..	17.922	………..	23.682
1804	………..	20.973	………..	27.714
1805	………..	20.396	………..	26.951
1806	………..	20.427	………..	26.992
	Averages	19.355 in.		25.577 in.

I find the average of seventeen years Rain (with some interruption in the series of years,) from 1774 to 1796, to be, by the same authority, 19.762 inches: none of the products composing it appearing to have been collected at the ground.

The **Monthly** results of my own Register for the ten years from 1807 to 1816, are detailed in the General Table D. Many of these, in the fore part of the series, are marked as having been obtained at forty-three feet elevation: to the annual totals of these results the same mode of correction has been applied, so far as it was required, and they come out as follows: the Mean Temperature of each year is annexed.

Year		Rain at the ground.		Mean Temp.
1807	………..	18.01 in.	……	48.367°
1808	………..	23.52	……	48.633
1809	………..	24.18	……	49.546
1810	………..	27.51	……	49.507
1811	………..	24.64	……	51.190
1812	………..	27.24	……	47.743
1813	………..	23.56	……	49.762
1814	………..	26.07	……	46.967
1815	………..	21.20	……	49.630
1816	………..	32.37	……	46.572
	Average	24.83 in.		

Lastly, the results obtained at or near the surface, for the years since elapsed, run thus:

1817	………..	24.80	……	47.834
1818	………..	25.95	……	50.028
1819	………..	24.30	……	50.116
	Average	24.87 in.		

The General average of all the results thus obtained for the ground, comprehending a period of twenty-three years, is 25.179 inches: I shall apply presently to the several years a definitive correction, through the medium of the Monthly results, which brings out an average still nearer to my own above stated.

WET AND DRY YEARS.

The greatest depth of Rain in twenty-three years fell in 1816. Next to this, for wetness, appears the year 1797.

The driest year in this period was 1807, and next to it 1802.

About one **year** in five may be said to be subject to the dry extreme, and one in ten to the wet.

After an extreme wet year, in 1797, we meet with four years in succession with an amount of Rain very near the average of the climate, and then an extreme dry year: and since the extreme wet year of 1816, we have again had three years in succession near the average.

CONNEXION OF THE ANNUAL RAIN WITH THE MEAN TEMPERATURE.

In the series of years from 1810 to 1816, the reader will find on comparing the Rain with the Mean temperature, that the warm years were uniformly dry, or below the average in Rain, and the cold ones uniformly wet, or above the average. This is a very natural coincidence; but do the effects depend on the alternate warmth and coldness of those years, or rather on the Mean temperature considered absolutely? In reference to this question, I may remark, that the Mean temperature of 1797 was 49.398, and that of 1816, 49.433 (Royal Society), and their respective amounts of Rain at the ground as above stated 29.996 and 32.87 inches. Again, as to dry years, 1802 had a Mean temperature of 50.200° with 18.428 inches of rain, and 1807 a Mean temperature of 50.733°, with 18.01 inches of rain. There is therefore probably a close connexion between the Mean temperature of many years, and the Rain at the earth's surface which attends them.

AVERAGE PROPORTIONS OF RAIN IN EACH MONTH OF THE YEAR: DEFINITIVE CORRECTION OF THE AMOUNTS FOR THE HEIGHT.

The product of Rain for the same month in different years, varies, in each of the months, greatly. This is a fact to which common observation is perfectly competent; and it is scarcely necessary to refer the reader to the General Table D for the proof in figures. Having constructed a similar Table from the Monthly results in the Philosophical Transactions, from 1797 to 1806, I found the same variety in them also. The same month which in one year affords five inches of Rain, in another exhibits not a quarter of an inch; or even (as appears in two instances) none at all, the few drops that fell having been inappreciable by measure. It became a question therefore, as before in the case of temperature, what should be regarded as the mean quantity; or the standard of comparison to which the product of a wet or a dry month should be referred.

The following are the **Averages** of Rain for the respective months as obtained by actual observation: the first series on a period of ten years, from 1797 to 1806, by the gauge of the Royal Society; the second on a similar period, from 1807 to 1816, from the results in my own register. In a third column are inserted the **average number of days on which any Rain fell**, in each month of the latter period.

Month		Average Rain for the Month by observation at different levels.		Number of days on which it rained
		1797-1806	1807-1816	
1.	Jan.	1.341	1.633	14.4
2.	Feb.	0.911	1.486	15.8
3.	Mar.	0.755	1.422	12.7
4.	Apr.	1.282	1.550	14.0
5.	May	1.340	1.921	15.8
6.	June	1.708	1.928	11.8
7.	July	2.555	2.578	16.1
8.	Aug,	1.925	2.102	16.3
9.	Sept.	1.833	1.522	12.3
10.	Oct.	1.671	2.740	16.2
11.	Nov.	2.400	2.407	15.0
12.	Dec.	1.631	2.093	17.7
	Totals	19.352	23.382 in.	178.1

I have not introduced here any **correction** for the difference of level, because it will be more interesting first to compare, the quantities as found.

In general, the average at the lower level exceeds; but in two cases the higher equals, and in one it exceeds the lower: which, considering they are for different periods of years, was to be expected.

In the months of September and November this is clearly due to excessive rains in those months, in four out of the ten years of the first series.

In October, the lower level is disproportionately in excess, from the same cause operating in the latter series.

Setting aside these cases, let us advert to the Seventh month. Here the rains are alike in both averages: and on examination, the respective Tables of results furnish no adequate reason for this. In 1806 there fell indeed in this month 4.889 inches at the higher level; but in 1800 the month was absolutely dry: the two taken together make an average near the one in the Table; and in other respects the results in each series present a very similar range of quantities.

If we recede again from this to the contiguous month, in either direction, we find in one of these a deficiency of an eighth, in the other of a ninth, in the higher level: which deficiency, in the months of Winter and Spring, becomes more considerable; the proportion in one instance amounting almost to the half of the sum of the lower product.

The probability is therefore very strong, on the evidence afforded by these averages taken in conjunction with my experiments in 1811, that the deficiency in the Rain collected at the higher level, from whatever cause or causes proceeding, is very small in the midst of Summer, and increases as we recede, in either direction, towards Winter. In the former season, the showers fall mostly from elevated clouds, and the lower atmosphere is generally clear of that misty precipitation which, in the winter months, must contribute something considerable towards the product at the ground. Add to this, that the effect of strong winds, in whatever way it robs the higher gauge, must be by far more considerable in the latter season.

On these considerations I have ventured to construct a Table of Monthly amounts of Rain, **corrected for the surface of the ground**; in which the rate of allowance is made to increase from 0.05 on the inch in the Seventh month, to 0.50 in the First, and decrease again through the remaining months in like proportion; the rate of gradation being 0.10 in Spring and Autumn, and 0.05 in Summer and Winter. These form the General Table H, at the end of the volume. I am aware that many of the cases, taken singly, cannot be accurate as they stand: there being seasons in which our Summer rains resemble the storms of Winter, and others in which the latter season has summer-like showers: but the whole twenty years, from 1797 to 1816, thus modified, afford an average of 24.808

inches per annum; which, it will be seen, differs by but a very small fraction from the averages found at the surface, or corrected on the evidence of experiment.

The annual results arising out of this mode of correction differ somewhat in amount from those obtained by estimating the deficiency on the whole year. The reader may give the preference (if he pleases) to the latter or corrected results, without its materially affecting the consequences I have drawn from the **estimated** ones.

It might have been expected that I should have here carried the parallel between the results of the Royal Society and those of my own gauge, through the remaining years published in the Transactions, and thus have settled the difference on the basis of actual observation in each case: but it is with regret that I acknowledge myself defeated in this object by an apparent falling off, of late years, in the conduct of that Register.

The years 1807, 1808, and 1809, present indeed an average of Rain which agrees sufficiently with the former averages, and is proportionate to the estimated results at the ground: but in 1810 we have no account of the Rain at all; and in 1811, for the latter half of the year only. From 1812 to 1818, the annual average sinks at once to about fifteen inches, the former averages deduced from long periods of years, having been about nineteen inches and a half! We have, however, a statement of the annual Rain in 1812, 1813, and 1814, by another Rain-gauge, placed a few feet distant from the former, and eleven feet six inches lower, the average of which is 20.349 inches; but the monthly results of this gauge have been neglected in the body of the Register, except in some instances where they appear to have crept in by inadvertence, or to be stated on the opposite page by way of contrast to the higher ones; though without notice of this circumstance to the reader. The only reason which I can assign to myself for this extraordinary deficiency in the higher gauge is, that the Rain being now measured (as it seems) only at long intervals, about a fourth part of that which is actually collected in the year escapes by evaporation.

If this learned and highly respectable body feels the subject of the weather no longer worthy its notice, would it not be better at once to dismiss the Register from its Transactions? But if, as in some sort the representative of our country in matters of science, it should be disposed to entertain an honourable emulation on this point with the Royal Observatory at Paris,* it will be necessary that much greater attention be paid than for several years past, both to the providing the requisite instruments and the due attendance upon them. For it is not in the article of rain alone, that defect or inaccuracy has introduced itself, to the degree almost of suspending confidence: an imputation which after being thus obliged to support (it having been already publicly advanced†) I should be equally ready to contribute in any degree to do away. [So far my First Edition: the subject will he resumed, as to the present state of this Register, further on.]

To return to the subject of the proportion of Rain which falls in the different seasons — the following Table exhibits the Monthly averages for the level of the ground for two periods of ten years each; the first set, corrected from observations at seventy-five feet elevation, the second in part corrected from observations at forty-three feet, but chiefly as obtained at the ground. The third column exhibits the two averages incorporated.

* The "Meteorological observations made at the Royal Observatory of Paris" are quite a model in point of care and exactness. They are published monthly in the "Journal de Physique;" and the results at least ought to be given, in our own language and measures, in the periodical Journals of this country.

† By Dalton, Manchester Memoirs, vol. 3, *second series*, p.490.

MONTHLY AVERAGES OF RAIN, CORRECTED FOR THE ELEVATION.

Month		1797-1806	1807-1816	1797-1816
1.	Jan.	2.011	1.907	1.959 in.
2.	Feb.	1.320	1.643	1.482
3.	Mar.	1.057	1.542	1.299
4.	Apr.	1.666	1.719	1.692
5.	May	1.608	2.036	1.822
6.	June	1.876	1.964	1.920
7.	July	2.683	2.592	2.637
8.	Aug.	2.117	2.134	2.125
9.	Sept.	2.199	1.644	1.921
10.	Oct.	2.173	2.872	2.522
11.	Nov.	3.360	2.637	2.998
12.	Dec.	2.365	2.489	2.427
	Totals.	24.435	25.179	24.804

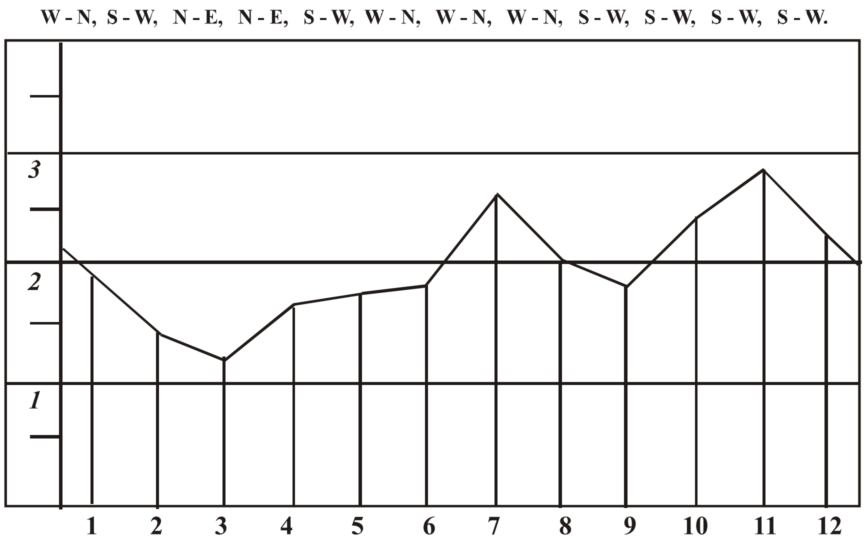
The wettest month, in a long run of years, appears by this method to be the Eleventh, or November; but on the evidence of the latter period, which has the most of actual observation for its support, the Tenth may dispute the precedency in this respect. Yet in perusing the amounts in the third column, we see the rain falling off in nearly equal proportions in each direction for two months from the Eleventh; which, as there was not the smallest adjustment to produce this effect, may seem to prove the mode of correction employed nearly accurate.

The next amount of rain is the Seventh, or July. From this month we have a diminishing series of amounts to the Third, or March, which is the driest; having only half as much rain as the Seventh, and a little more than two-fifths of the quantity of the Eleventh month. In the first series of years, the Third month is comparatively dry, and the Ninth wet: in the second series the Third is wet, and the Ninth dry, compared with the general average: the reader will find many examples of the same contrast in the particular years on which the averages are founded.

From the Third month, proceeding forward, we see the rain grow larger in amount to the Seventh, then less to the Ninth, and larger to the Eleventh again.

The following diagram exhibits the gradation of Rain through the year, on a scale of half the depth.

FIG. 20.



PROPORTIONS OF RAIN IN THE DIFFERENT SEASONS

In an Essay read in 1818, by my friend John Dalton, before the Literary and Philosophical Society of Manchester, the author concludes from different averages, "that the first six months of the year must be considered as dry months, and the last six as wet months; that April is the driest month in the year, and the sixth after, or October, the wettest."

My own averages perfectly coincide with his first proposition, if only the slight difference be neglected by which September falls below the mean.

If in the results here advanced the driest average falls a month earlier, and the wettest a month later than in his statement, it may perhaps he attributed to the difference, in exposure and latitude, of the two stations, Manchester and London. The latter may be thought to lose the hibernal rains earlier from its more forward spring, and to receive them more slowly in consequence of a more prolonged summer.

With regard to the proportions of Rain in the former and latter half of the year, they stand thus, by the average in the third column:

For the first six months (Jan.-June.) …………………………………………………. 10.174 in.
For the latter six months (July-Dec.) ………………………………………………… 14.630

The two portions of the year thus divided [about the Solstices,] are nearly equal in their total heat: the sum of the mean temperatures for the first six months being 280, 32, 280, 32, and that of the last six 315, 47.

But if we divide the circle in another place, [to wit, about the Equinoxes,] we shall have a very different result:

From the Fourth to the Ninth Month inclusive (April-Sept.) the average rain amounts to ………………………………………………………………………... 12.117 in.

And from the Tenth to the Third inclusive (Oct.-March) to ………………………... 12.687

Now the sum of the mean temperatures of the first six months in this series (or the summer half year) is ………………………………………………………………. 345.94

and that of the remaining six months (or the winter half year) …………………………. 249.85

Thus in dividing the year in one way, we have very unequal amounts of Rain for the two moieties, with nearly equal amounts of heat; and in another way, very unequal temperatures, with nearly equal amounts of Rain. If instead of taking the results of whole months, the division had been made at the days of extreme and mean temperature, the contrast would probably have been still more perfect, at least as to equal temperatures with unequal Rain: but the more direct method suffices for the object.

The solution of the whole case seems to be as follows:- In the former half of the year (that is, from some time in the First month,) the mean diurnal heat is advancing; or if it be kept down by a succession of Northerly winds, these arrive in a state to promote evaporation, and dry up, rather than deposit moisture: in the latter half (that is, from some time in the Seventh month) the heat is declining; or if it be sustained towards the close of the year, by Southerly winds, these coming into a colder latitude deposit their water in consequence. Thus there is prevalent, during the former half of the year, a cause which powerfully counteracts the production of Rain; and during the latter half, a cause which more than any other promotes it: the quantities of effect are therefore very unequal.

But in dividing the year at the points of mean temperature, we set these causes in opposition to each other, in either moiety. The effect on the rain of the depression of the mean temperature in the last three months of the year, is counteracted by an elevation in the first three months; and the elevation continued through the three months of Spring, balances in effect the depression which ensues in the course of the three months after Midsummer. The quantities of effect in the two moieties are therefore equal.

Consistently with this statement are the proportions of Rain for the four quarters of the year, taking (as before in the case of Evaporation) the Twelfth, the First, and Second as **Winter**, and the remaining months in classes of three, for the other seasons:

		Rain		Mean Temp.
Winter	…….	5.868 in.	…….	37.20°
Spring	…….	4.813	…….	48.06
Summer	…….	6.682	…….	60.80
Autumn	…….	7.441	…….	49.13

The Rain, it appears, is not, any more than the evaporation, proportionate to the **Mean temperature of the season**. Yet if we add together the mean Rain and mean Evaporation for each season, the **sum of the two** will be found in pretty near proportion to its Mean temperature: the sums are,

For Winter	………..	9.455
For Spring	………..	13.669
For Summer	………..	18.262
For Autumn	………..	13.885

PROPORTIONS OF RAIN BY DAY AND NIGHT, &c.

In the early part of my observations I frequently measured off the Rain which fell by day, and separated the result from that of the following night. As this was done only through the years 1807 and 1808, which are both below the average in Rain, and with the higher gauge only, I do not attach much importance to the results.

Of 45 inches of rain, which fell in the space of 31 Lunar revolutions, I divided 21.94, and found 8.67 to have fallen with the Sun above the horizon, and 13.27 during his absence. According to this experiment, the Rain by day makes only two thirds of the quantity that falls by night.

The greatest rain in twenty-four hours that has fallen under my observation, (or rather that of my assistant, for I was shut up in the packet going to Helvoetsluys,) was on the day and night of the 26th of Sixth Month, 1816. On this occasion, the night in particular was very wet and stormy: the gauge at our Laboratory, Stratford, near London, collected 2.05 inches, between 9 a.m. the 26th, and the same hour the following morning. I have already noticed the character of that season, which was at once the coldest and the wettest in twenty years. See Table CXX &c. of the Observations.

In reverting to the column, p.67, entitled "Number of days on which it rained" in each month, the reader will perhaps be struck with the fact, that in our climate, on an average of years, **it rains nearly every other day, more or less**. He will perceive, however, that the number of days (of twenty-four hours) on which there falls any rain, is less in the longest days than in the shortest, in the proportion of two to three.

The propensity to frequent dripping, even in this dry corner of our Island, I consider to be connected with our moderate and variable temperature. In climates the mean temperature of which, from the circumstance of Latitude alone, departs further in either direction from the mean temperature of the Earth, it is probable the number of **dry** days will be found greater, in proportion as the climate is hotter or colder than our own. It will be an interesting enquiry for those who are sufficiently zealous in these pursuits, and who possess the requisite leisure, to follow out the comparison through the many registers of the weather already published. The circumstance of elevation above the sea, which when not excessive, greatly tends to promote Rain, will require the exclusion of some registers from this comparison; unless indeed the mean Rain for a certain range of latitude be deduced from the whole of the registers kept at different elevations within its limits.

POPULAR ADAGE OF 'FORTY DAYS RAIN AFTER ST. SWITHIN,' HOW FAR FOUNDED IN FACT

The opinion of the people on subjects connected with Natural History, is commonly founded, in some degree, on fact or experience: though in this case, vague and inconsistent conclusions are too frequently drawn from real premises. I have already stated, under Tab. LXXXIII that the notion commonly entertained on this subject, if put strictly to the test of experience, **at any one station** in this part of the Island, will be found fallacious. To do justice to popular observation, I may now state, that in a majority of our summers, a showery period, which with some latitude as to time and local circumstances may be admitted to constitute daily Rain for forty days, does come on about the time indicated by this tradition: not that any long space before is often so dry as to mark distinctly its commencement.

The tradition, it seems, took origin from the following circumstance. Swithin or **Swithum**, Bishop of **Winchester**, who died in 868, 'desired that he might be buried in the open church-yard, and not in the chancel of the minster, as was usual with other bishops, and his request was complied with: but the monks on his being canonized, considering it disgraceful for the saint to lie in a public cemetery, resolved to remove his body into the choir; which was to have been done with solemn procession, on the 15th of July; it rained however so violently for forty days together at this season, that the design was abandoned.'* Now, without entering into the case of the bishop, (who was probably a man of sense, and wished to set the example of a more wholesome, as well as a more humble mode of resigning the perishable clay to the destructive elements,) I may observe that the fact of the hindrance of the ceremony by the cause related is sufficiently authenticated by tradition: and the tradition is so far valuable, as it proves that the summers in this Southern part of our island, were subject a thousand years ago to continued heavy rains in the same part of the season as at present. Let us see how, in point of fact, the matter now stands.

In 1807, it **rained** with us on the day in question, and a dry time followed. In 1808, it again rained on this day, though but a few drops: there was much lightning in the West at night, yet it was nearly dry to the close of the Lunar period (at the New Moon) on the 22d of this month, the whole period having yielded only a quarter of an inch of rain: but the next moon was very wet, and there fell 5.10 inches of rain.

* Time's Telescope, or Guide to the Almanac, 1814.

In 1818 and 1819, it was **dry** on the 15th, and a very dry time in each case followed. The remainder of the summers occurring betwixt 1807 and 1819, appear to come under the general proposition already advanced: but it must be observed, that in 1816, the wettest **year** of the series, the Solstitial abundance of rain belongs to the Lunar period **ending** (with the Moon's approach to the Third quarter) on the 16th of the Seventh month; in which period there fell 5.13 inches, while the ensuing period, which falls wholly within the forty days, though it had rain on twenty-five out of thirty days, gave only 2.41 inches.

SOLSTITIAL AND EQUINOCTIAL RAINS.

Our year then in respect of **quantities** of rain, exhibits a **dry** and a **wet** moiety. The latter again divides itself into two periods distinctly marked, as the reader will perceive by viewing the two elevations of the curve in Fig. 20, p.70. The first period is that which connects itself with the popular opinion we have been discussing. It may be said on the whole, to set in with the decline of the diurnal Mean temperature, the maximum of which, we may recollect, has been shown to follow the Summer solstice at such an interval, as to fall between the 12th and 25th of the month called July. Now the 15th of that month (or Swithin's day) in the old style, corresponds to the 26th in the new: so that common observation has long since settled the limits of the effect, without being sensible of its real cause. The operation of this cause being continued usually through great part of the Eighth month, the rain of this month [on the first average,] exceeds the mean, by about as much as that of the Ninth falls below it.

The latter wet period corresponds to the second great elevation in the curve. It begins by a large addition to the amount of rain in the Tenth month; its middle and wettest part falls in the Eleventh; and it goes off by a similar gradation of amount in the Twelfth. As the former period apparently takes its origin from the Summer solstice,* (though, like the highest temperature, not

* The great rains in Abyssinia and the neighbouring countries, on which depend the annual overflowings of the Nile, have a period coincident with that of our own **Estival** rains. The dry season, according to Bruce, gives place to light rains about the Vernal Equinox, but there falls no considerable quantity in any place until the Sun arrives at the zenith of that place: from which time, until in returning southward he becomes again vertical to them, all these parts are subject to heavy rains; which cease as to the whole country a little before the Autumnal Equinox. The following are the monthly proportions of the rainy months on a medium of two years, according to a journal kept by Bruce's assistant **Balugani**, at Gondar in 1779, and at Koscam in 1771.

May 2.609 in.	Aug. 12.794 in.
June 5.347	Sept. 5.086
July 12.224	

And it is remarkable that in these parts of the world they have a second rainy period, of much less extent, and as it seems, less certain than the former; which falls about the close of October and beginning of November. Thus in Summer we partake in a less degree, and with some uncertainty, in the operation of the causes which produce the Tropical rains; and in Autumn the Tropical regions are affected, in a lower degree, by the causes of our more complete precipitation.

I attach little to the show of minute accuracy with which this Journal of Bruce's is got up; there being, after all, some inconsistencies apparent, owing perhaps to the press: but I think there is internal evidence of its being a real Register, which may be depended on for general results. His account of the manner of the falling of those Abyssinian Thunder-showers, in a country so elevated that the Barometer stood at 22 inches is, though very unphilosophical, an interesting record: since the phenomena which he there attempts to describe, may often be witnessed day after day in our own climate, though so near the level of the sea, at the same season. "Every morning in Abyssinia is clear, and the sun shines. About nine, a small cloud not above four feet broad, appears in the East, whirling violently round as if upon an axis; but arrived near the zenith, it first abates its motion, then loses its form, and extends itself greatly, and seems to call up vapours from all opposite quarters. These clouds having attained nearly the same height, rush against each other with great violence; the air impelled before the heaviest mass or swiftest mover, makes an impression of its own form in the clouds opposite, and developed till after a certain interval,) so this occupies much of the interval between the Autumnal Equinox and the Winter solstice, its termination being apparently fixed by the latter. I propose therefore to distinguish the two by the terms, Summer or **Estival**, and **Autumnal** Rains; meaning thereby not the entire quantities of rain falling in the midst of two seasons otherwise dry, which would be inapplicable to our climate, but simply the **excess** of rain, which on a mean of years the two periods afford us.

The **Equinoxes** themselves are in our climate comparatively **dry**, the Vernal especially; and they are attended with the remarkable circumstance of an occasional anticipation by the **Vernal**, of a share of the rain which might be expected to accompany the **Autumnal** Equinox. Were it not for this curious connexion, the Ninth month would not be **dry**, but would have its rain above the mean of the year: [on the average of thirty-four years it is wet.] The reader will find this translation to have happened in the years 1801, 1804, 1810, 1812, 1814, and 1815; by comparing in the general Tables, the amounts of rain for the Third and Ninth months respectively.

CONNEXION OF THE RAIN WITH THE WINDS.

I have placed at the head of the diagram, p.70, the prevailing wind for each month, or rather the **class** which exhibits the highest number for the month, in the average of ten years given in the Table, p.75. It appears at once that a wind between North and East is connected with our driest season, about the Vernal Equinox; and a wind between South and West with the wet season following the Autumnal.

There is a regularity in the succession of the winds in the first six months, of which till I came to this part of the work I had not suspected the existence. The classes run thus, W-N, S-W, N-E, N-E, S-W, W-N. After this, the class W-N prevails during the Summer, and the class S-W through the latter four months of the year.

The connexion of a different class of winds with the **Autumnal** from that which prevails during the **Estival** rains, may be admitted as a proof, that the two periods which have been described, are really distinct effects, produced by different arrangements of the causes of rain in the atmosphere.

On summing up the horizontal columns of observations on the wind in Table D, which comprehend a space of ten years, I found the following to be the annual amounts of the several classes; which are here put in comparison with the **corrected amounts of Rain** for those years.

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the moment it has taken possession of the space made to receive it, the most violent thunder possible to be conceived follows, with rain. After some hours, the sky clears with a wind at North; and it is always disagreeably cold when the Thermometer is below 63°. When the sun is in the Southern tropic, 36 degrees distant from the zenith of Gondar, it is seldom lower than 72°, but it falls to 69°, when the sun is immediately vertical." Bruce's Travels, Book vi. Chap. 15 and 19.

The whirling cloud which makes such a figure here as the precursor of the storm, I believe to be the first appearance of the *Cumuli*, which it is afterwards made to call up around it, and which he may have observed at times coming on from the windward with a rapid introversion of the **apex** upon the **body** of the cloud, as sometimes happens here before heavy rain. The rest is merely a confused description of the gathering of a thunder-storm; in which, instead of the air carrying the clouds [now become *Cumulostrati*,] the latter are made, like projected solids, to propel the air before them, and thus remove the neighbouring clouds in order to take their places!

The short notice respecting the temperature proves that a warm vaporous, current, probably from the neighbouring Arabian gulf, is decomposed by the action of a colder Northerly one; and the whole of the circumstances represent, on a grander scale, the weather of a wet thundery summer in this climate.

Year	N-E	E-S	S-W	W-N	Var.	Rain
1807	61	34	113	114	43	20.14 in.
1808	82	38	108	103	35	23.24
1809	68	50	123	91	33	25.28
1810	81	72	78	83	41	28.07
1811	58	59	119	93	36	24.64
1812	82	66	93	91	34	27.24
1813	76	53	92	124	20	23.56
1814	96	65	91	96	17	26.07
1815	68	36	121	107	33	21.20
1816	64	66	106	102	28	32.37
Averages	74	54	105	100	32	25.18 in.

This Table affords some very striking results, as to the manner in which the several annual quantities are related to those of the Rain.

In the driest year of the whole, which is 1807, the class N-E has nearly double the number of the E-S; in 1815, the next for dryness, the same; and in 1808, which stands third, rather more than double.

In 1816, the wettest year, on the contrary, the class E-S exceeds the N-E: in 1814, it has two-thirds of the amount of the latter; in 1812, three-fourths; and in 1810, the remaining wet year, the amount comes within a ninth of the N-E; both classes being large, and the Westerly winds falling off in a remarkable manner to make room for them.

The year 1811, which presents about an average of rain, has the features, in respect of winds, of a wet year. On examination, I find that 36 out of the 59 observations here forming the E-S class are put down as an East wind: and in 1809 and 1813, the two remaining years, both a little below average, the majority of the observations in the second class are of the same kind.

These proportions, then, confirm the relation, already exhibited in the diagram, of a NE wind to the dry weather; and they establish another relation between a SE wind and the rain of our climate.

With regard to Westerly winds, the class W-N, we may observe, falls off gradually during the three years following 1807, while the annual rain increases from year to year: and in four of the remaining years, its number is above the average in the dry years, and below it in the wet ones. There is therefore a manifest general relation of this class to our fair weather.

The winds between the South and West have no decided connexion with either a wet or a dry year.

This proposition may seem at variance with the connexion exhibited in the diagram, and with the remarks upon it, which appear at the beginning of this section: but the contradiction is apparent, not real, as will be seen in what follows.

GENERAL IDEAS ON THE RAINS OF THESE LATITUDES.

There are two ways in which we may conceive Rain to be produced in a temperate latitude: First, by the cooling of the whole mass of the atmosphere to a degree sufficient to decompose its vapour. This happens when, either the air flowing constantly from South to North, leaves the influence of the Sun behind it; or the Sun, declining in Autumn and retiring to the Southward, leaves the air to cool where it remains. In effect, both causes may be in action together; as is probably the case during some part of every autumn in these latitudes.

Secondly, by the cooling of a portion only of the air — from the intrusion, or the overflow of a warm vaporous current, from a lower latitude into our own; where it loses its heat, and has its vapour decomposed by our colder air.

In the first case, the Rain will be formed in every part of the atmosphere, up to a certain height at least from the ground; where the vapour diffused through a rarefied medium can afford only a kind of hazy precipitation, which gradually descends upon the lower air. In the second case, showers, and hail with thunder, if the contact be very sudden between the currents, are generated; which fall from a greater height, and are commonly much less **continuous** than the other kind of rain.

Both of these modes of production, again, may be in action together for a time. A Southerly current, charged with vapour from a warmer region, may be passing Northward, at the same time that a Northerly current may he returning towards the South, in the immediate neighbourhood of the former; and these two may raise each other, the colder running in laterally under the warmer current, and causing it to flow over laterally in its turn; while each pursues in the main its original course. In this case the country, for a considerable space extending from about the line of their junction far into the Southerly current, may be the seat of extensive and continued rain.-

PARTICULAR CASES OF RAIN, &c. EXAMINED.

Tab. I-II., [Vol. II] In these two periods a mean quantity of rain was brought by strong SW winds. Once, when there fell 0.63 in. the nocturnal Temp. was depressed 12°, several hoar frosts ensued, and a positive electricity was manifested before the rain: all which indicates the interference by night of a Northerly wind.

A Thunder-storm (Dec. 2) seems to be connected with the ensuing dry winter.

Tab. VI-VII. After a dry time of long continuance, the Fifth Month gave between two and three inches in the first fifteen days, **six** of which had variable winds. During these rains, which brought warm weather (although from NE and E,) there was an abundant development of electricity. On a sudden depression of Temp. at the close of the month, there fell 0.82 in. the wind getting to S and Var.: then after two days fair with NW, the return of variable winds brought an inch and a quarter of rain. After which, with Westerly winds, the whole period, Tab. VIII, was dry and **non-electric**; though upon the change from SW by W to NW, some thunder clouds made their appearance.

Tab. X. In this period we have a rain of 0.93 in.; from the NW displacing the SE, attended with much lightning in the night: max. Temp. depressed from 81° to 72°.

Tab. XI. A rain of 0.65 in. clearly due to a depression of Temp. (by a Northerly current) of 10° on the day and night. And towards the close immediately after the Autumnal Equinox, a wet week, apparently from a mere South wind; which **raised** the Temperature, while the Barometer fell.

Tab. XII. In the latter part of this period, we have seven wet days with a considerable depression of both Barometer and Thermometer, indicating an extensive decomposition of the aqueous atmosphere; the brunt of which appears by the Note to have fallen upon the country about **Paris**. The winds are here a perfect mixture, *viz.* S, Var., NW, N, SE, E, N, SW, W, N: crossing the compass in both directions.

Tab. XIII. Here we have 0.61 in. of **Snow** by the NW supervening upon the SE: the latter wind is inserted upon the authority of the Philo. Trans. as my own observation is wanting. In the same period, 0.49 in. **Snow** and **rain**, connected with three days Var.

Tab. XV. The first days of 1808 presented an example of the effects of the interference of a partial current. A course of dry SW winds, of eighteen days duration, is interrupted in the middle by one day **South**, probably in its origin SE; the result is 0.65 in. of rain.

Tab. XVIII. After four days **variable** winds, 0.59 in. of water from **Snow**, attended with positive and negative electricity. This was on the 20th of the Fourth Month, 1808. The 17th of the same month in 1807 was distinguished by a snow-storm, and the 19th by a succession of electrical Nimbi discharging dry hail: and the 20th and 21st of the same in 1809, by plentiful snows, followed by hail and rain. In the two latter cases the NE and SE winds appear to have been in simultaneous action: in 1808 the winds are not specified. This analogy gives place to fair weather at the same season in 1810: but in the subsequent years, I find **hail** noted, for the most part, about the same time in the month. There is therefore probably a periodical current from the North at this season, in the higher atmosphere, the arrival of which is determined by the Sun's progress in North declination.

A case remarkably analogous, and which may prove important in regard to a future theory of the Atmospherical variations, occurs while I am occupied with the present sheet [1st Ed.] of this work.

On the 19th instant (Second month, 1820,) after a considerable depression of Temperature for the season (there having been no snow for near a month,) it began to **snow** early in the afternoon, and there fell in the course of the ensuing night and day a considerable quantity, making 0.78 in the gauge when melted. Now, from the 21st of the Twelfth Month (the shortest day) to the date of this snow, is sixty days; and from the date of the heavy snow with which this winter began (prematurely as we thought) at noon, on the 22d of Tenth Month, to the shortest day, is also sixty days. Should the winter terminate with this snow, which has been followed, after a thaw, by some night-frosts, it will have lasted, with the usual mild intervals included, an hundred and twenty days, beginning and ending at the same point of the Sun's declination. In this respect then, our winter will have been co-incident, for once, with that of a much higher latitude: and as we have been intruding of late years, with our ships of discovery, into the polar circle, the **North** may be said to have **returned the visit!**

To proceed.- Tab. XXII exhibits a good specimen of the Solstitial rains. The period begins with a SE wind, and a max. Temp. of 85º. In five days, with 2.76 in. of rain, and thunder, it is lowered to 67°, the Temp. of the nights keeping up: the winds these five days as follow, S, NW, NE, E, W. The Evaporation, which is about 0.10 in. *per diem*, certainly proves nothing in favour of a **saturated** state of the lower air all this time. The NW, W, and SW prevailed on the few fair days in this period, which had in the whole 5.10 in. of rain. See also Tab. XLVII, LIX.

In Tab. XXV, we have several considerable amounts of rain brought by strong SW winds; while a little rain likewise attends the interruption of the course of NE, immediately succeeding.

Tab. XXXI. Here we have a remarkable succession of the daily winds during rain, **and which proves introductory to fair weather**. First, Fourth month 14, **var**. with thunder and hail, then SW, W, NW, N, SE, NE, and, after a few days of changeable winds, the reverse order, NE, N, NW, W, SW, with a day **variable** at the commencement of the dry weather, which prevailed for the most part during the month after.

Tab. XLII. In this period, at the beginning of Spring, we have a striking contrast between the effects of the Southerly and Northerly winds: a course of the former, with daily rain, giving place in the middle of the period, to a course of the latter, with dry weather and frequent hoar frosts.

Tab. LI. (Eleventh month 19, to Twelfth month 18, 1810.) We have here the enormous amount of 5.54 inches of rain in the space of thirty days, with appropriate winds, and an **Electricity** which might have become the heats of summer. Whether from this cause, or from the temperate warmth and moisture by night, or both united, the *Ignis fatuus*, a phenomenon scarce known in this part of the island, appeared in the marshes near our Laboratory, on several nights during a very wet week; and gave place only to the overflowing of the river, which laid the ground under water. I did not get to see this rare visitant, and am consequently unable to speculate, from actual observation, upon its nature; but some circumstances which were told me by an eye-witness, respecting the brightness and swift gliding motion of the lights, induced me to think them electrical; and I am disposed to class them in the present instance with the smaller kind of **shooting stars**, though making their appearance is so very different a region of the atmosphere. It is possible that the evolution of phosphuretted hydrogen gas may sometimes produce luminous phenomena in these situations; but on this supposition they ought to appear more frequently. Lastly, to conclude these conjectures, there are extant descriptions of *Ignes fatui*, which are scarcely to be explained on any other hypothesis, than that some insect, with which we are perhaps acquainted in its ordinary appearance by day, becomes luminous when collected into dense swarms, and flying thus by night.

Tab. LXI. A contrast in the opposite season (if we include also a few days of Tab. LX) to the arrangement of winds and rain in Tab. XLII. Here we have a course of dry Northerly and Easterly winds, followed by a series of Westerly gales with daily rain; the introduction of the latter being marked by **three** days of SE and S; and one **variable**.

The crossing of the currents, and the effects of their mutual contact in electrical precipitation, appear in some extracts from the Papers annexed to this period. See the Notes respecting the winds at **Plymouth** and **Harwich**: and compare with these the winds at **Plymouth** and **Hull**, under Tab. LXVII. Both cases being evidently connected with the Equinoctial season, and introductory to rains about equal in amount and duration.

Tables LXV, LXVI, and LXXIV, exhibit a great number of instances of the connexion of the S and SE crossed by the NW, as also of the variable winds, with heavy rain, both in the early and latter part of the year. The usual electrical phenomena ensue, upon the copious decomposition of the vapour, in each season.

Tab. LXIX. In this period the gradual **southing** of the wind before rain is thus twice exhibited in its daily changes, 1. NE, E, SE, SW; then under different winds during a week, 0.60 in. rain. 2. N, NE, E, SW; during this, again, 0.61 in. rain, and immediately with **Var**. for one day 0.60 in. rain. Then NW a day, **fair**: then, E, SE, SW S, SE, SW; S, SW; with 0.55 in. rain in ten days; after which followed two weeks of dry weather with a high barometer.

Tab. LXXXI. has a curious mixture of winds, with continued rains, in the Spring season; and, as usual, thunder: but it would be tedious to point out to the reader the many cases which he may find (if disposed to prosecute the enquiry) in these Tables.

PROBABLE SOURCES OF THE VAPOUR BROUGHT BY DIFFERENT WINDS

The introduction of a surplus of vapour from the S or SE, and its decomposition by the prevalent NW, and in some cases the W and SW winds, will now be evident: as likewise the reason why the SE wind is so intimately connected with Electrical indications, with hail and thunder.

Vapour brought to us by such a wind must have been generated in countries lying to the South and East of our island. It is therefore probably in the extensive vallies watered by the Meuse, the Moselle, and the Rhine, if not from the more distant Elbe, with the Oder and Weser, that the water rises, in the midst of sunshine, which is soon afterwards to form **our** clouds, and pour down in **our** Thunder-showers. And this island, in all probability, does the same office for Ireland: nay, the Eastern for the Western counties of South Britain. My attention was lately called to this subject by a striking fact, which occurred in preparing Tab. CXXXI for press. After nearly nine days' wet weather, attended as usual with mixed winds, in our district, upon the wind changing from SE to NE, it became fair with us; and on the same day (the 26th of Fifth Mo. 1817,) a rain of three days and nights commenced in the country East of the Upper Rhine about **Stuttgard**, so heavy as to produce a serious inundation. In the mean time we had no rain, though the Barometer was still very low, and the change of the wind above mentioned had been attended with thunder. The rain ceased in those parts upon the evening of the 28th, and on the next two days it rained again with us. To suppose a connexion of the phenomena at this distance on electrical principles may be too much: but I think one may be made out through the medium of the winds in this manner. The evaporation of a tract of country lying to the east of both stations, might in the first instance be conveyed to the Thames, and then, by a change in the direction of the prevailing wind, to the sources of the Rhine; and decomposed into rain with us by the effect of a colder latitude, and with them by that of the elevation of the country: aided probably in both cases by opposing currents.

Thus, drought and sunshine in one part of Europe may be as necessary to the production of a wet season in another, as it is found to be on the great scale of the continents of Africa and South America; where the plains, during one half of the year, are burnt up, to feed the springs of the mountains; which in their turn contribute to inundate the fertile vallies, and prepare them for a luxuriant vegetation. And we may now be more able to understand the unequal distribution of the wet summer of 1816; when, as I have already stated under Tab. CXXII, the middle of Europe was subjected to excessive rains, at the same time that the North, or the parts East of the Baltic, about Dantzig and Riga, were suffering from drought; and in all probability furnishing the water.

In the Spring and Summer, both the direction of the winds, and the relative state of Temperature, seem to forbid our receiving much rain from the **Atlantic**. But in winter, when the surface of the ocean is giving out heat to the air, it may be supposed also to give out vapour, in greater quantities than the Temperature of the air is prepared to sustain. Hence the Atlantic, during the winter months, or rather in the interval between the Autumnal equinox and the Winter solstice, is probably the great source of our rains. The impetuous gales which, at this season, move over its surface, and impinge on our Western shores, may possibly bring us much vapour from the superior atmosphere of the Tropic in which they originate. The powerful manifestations of Electricity which at times attend them, seem to favour this opinion. But should they have deposited much water on the passage, we may still find, in the relative winter temperatures of the air on our coasts, and on the ocean, a sufficient reason for the **turbid** state in which they are almost uniformly found on their arrival.

HUTTONIAN THEORY OF RAIN REJECTED

[The safest course that we can follow, in reasoning on subjects connected with the operations of nature, is undoubtedly that of direct induction from observation and experiment: and in this we may be allowed to avail ourselves, not only of our own, but like-wise of the published results of others. It sometimes happens, nevertheless, that the mere sally of an ingenious reasoner, especially if it be supported by an appearance of mathematical demonstration, shall obtain general acceptance on the credit of his name and previous labours, **without the least pretension to experimental proof or natural observation of any kind**. Such is, in fact, the so much praised **Huttonian theory of Rain**; which I was induced to reject, after some consideration, on comparing it with the facts and inferences, founded on experiment, contained in different works on the subject of **latent heat**, and the **capacities of bodies for heat**, which I had recently been studying. This was, I think, about the time that I was forming my system of the "Modifications of Clouds:" and I read to the **Askesian Society** an Essay, now in my possession, in reply to one produced by a fellow-member in recommendation of the Doctor's hypothesis.]

The principle advanced by Dr. Hutton is this; that when two portions of saturated air mix together, the common **Temperature** will be reduced to a medium between the temperatures of the two, while the **Capacity** of the mixture, or its power of retaining water, will be much below the medium; and precipitation will ensue from this circumstance alone. This principle the Doctor thought applicable to every case of rain that could happen; and not only to these, but also to the production of clouds and mists, in whatever circumstances or situations they may be found. [The very **dew** of the evening was made to result from such mixture.]

It is certainly of great importance to establish general principles, on which we may reason conclusively respecting any case which may present itself in Nature; and when informed of the premises, be able to determine that such or such consequences **must** ensue: but I confess I doubt, notwithstanding the too hasty authority of some profound reasoners in its favour, whether Meteorology will really gain a step by adopting this system.

"That the quantity of vapour capable of entering into air increases in a greater ratio than the temperature," is a proposition which appears to rest on the basis of experiment: but "that whenever two volumes of air of different temperatures are mixed together, each being previously saturated with vapour, a precipitation of a portion of vapour [water,] must ensue," is at present demonstrated by no experiment that I know of; and requires, I think, to be re-considered. The reason given is, that the mean Temperature is not able to support the mean quantity of vapour:* but are we sure that the Temperature in this case will be in the Arithmetical mean? We know that such is the result with **homogeneous** bodies, as with equal volumes of hot and cold water: but volumes of air, saturated with water at different temperatures, are in the case of heterogeneous bodies: they differ in **composition**, the warmer mixture containing the most of aqueous vapour. The specific heat of aqueous vapour is given at 1.55, while that of air is 1.79, water being unity. Such a mixture will therefore probably have a temperature differing from the Arithmetical mean; and **possibly** differing in such a way as to prevent the precipitation of any water in consequence of the equal distribution of the heat in the mixture. Crawford states (Exp. and Obs. &c. p.85, 2d Ed.) that 'Unequal quantities of absolute heat are required to produce equal alterations of Temperature in equal weights of heterogeneous bodies.' This experiment was made on solid and liquid bodies; but the inference to gaseous ones is unexceptionable, the principle being admitted.

* Dalton, Manchester Memoirs, vol. iii. second series.

I am doubtful, secondly, of the **fact** of the intimate mixture of large masses of the atmosphere, in the manner and to the extent required by this hypothesis. [The most violent hurricane does not effect it; for the clouds, in such cases, keep still on in their course.] The natural appearances are against it. We can often trace, during the approach and in the intervals of rain, the gradual descent or subsidence of a superior current, which sooner or later manifests itself at the surface, by a wind there flowing in the same direction. Often in summer, two or more of these may be detected; which, after quietly flowing over each other, without any extraordinary precipitation, or in some cases (as when observed by means of balloons) without any turbidness at all, come down in succession, during several subsequent days of fair weather. Supposing these to have been all saturated with water, what should have made them more liable to mix than in the case described? That they do not mix at all in the plane of contact, is not what I maintain; but that the intimate mixture of the whole elements of the atmosphere, from the height of some thousand feet down to the earth, and this every time that it rains largely, is not from appearances at all a probable supposition.

Many phenomena attending the production of dew, mists, and clouds, might be cited as adverse to the opinion of such extensive intermixtures of the higher and lower atmosphere: but leaving the question of the *modus operandi* in the case, to be settled by those who incline further to discuss it, I may state, as matter of experience, that the contact and opposition of different currents **charged with aqueous vapour**, and (by inference from their state as they manifest themselves in succession at the surface) **differing in temperature**, is largely concerned in the production of our Vernal and Estival rains.

When after a suffocating heat with moisture, and the gradual accumulation of Thunder-clouds followed by discharges of Electricity, I observe a kind of Icicles* falling from the clouds, then large hail, and finally rain: when after this I perceive a cold Westerly or Northerly wind prevail, I have a right to infer, that the latter, aided by the electrical energies, has been acting, **as a cold body in mass**, in a sudden and decided manner, on the warm air in which I was placed before the storm. Again, when after a cold dry North-East wind I behold the sky clouded, and feel the first drops of rain warm to the sense; and after a copious shower perceive the air below changed to a state of comparative warmth and softness, I may with equal reason conclude, that the Southerly wind has displaced the Northerly; manifesting itself first in the higher atmosphere, and losing some of its water by refrigeration in the course of the change. Doubtless **mixture**, in each case, obtains to a certain degree, and accelerates the effect; but it does not appear to me a **necessary** previous condition. On the contrary, the occurrence of rain, when the air is rather dry by the Hygrometer below (as sometimes happens) with the sudden increase of evaporation which often ensues upon rain, convince me that **temperature** may effect an occasional precipitation at the plane of contact, **such as the general state of the atmosphere**, [in respect of moisture,] **had time been given for its operation**, [by mixture,] **would have prevented**. Nothing is more common than to see vapour issuing into a **dry** air (provided it be cold enough) decomposed by the contact of the latter, and yielding a copious **steam**, which is presently afterwards **taken up again**. [And this happens also with oily and other vapours, as chemists every day witness in their processes.] In the same manner I suppose an occasional precipitation to take place, even to the degree of rain, by the mere circumstance of the sudden translation of a vaporous current into the midst of a cold medium; or of the irruption of the latter upon vaporous air at rest.

I make no use here of the effect of different Electricities, which may obtain in currents brought from a distance and acting on those which they meet, to produce rain; because I am inclined rather to consider the Electrical phenomena attendant on Rain as **secondary**, and depending on the previous separation of watery particles in some degree of aggregation, by the great and universal cause of rain, **depression of the temperature of vapour**.

* I witnessed such a phenomenon at Meriden near Coventry, on the 19th of Seventh Mo. 1803, when the large hail broke the windows in that city. The reader will find a more striking instance of intense sudden precipitation, in the account of the Gloucester Thunder-storm, under Tab. XXI of my Observations.

The previous reasoning is meant to apply to the apparent anomaly, of a North-West wind predominating in our wettest season in summer, and a South-West during the autumnal rains. I conclude from a careful review of the cases, that the former is not the carrier, but the **condenser** of the vapour; which appears to be introduced at intervals only, from the South and South-East. When the surplus vapour has been disposed of in rain on these occasions, the North-West resumes its sway, the atmosphere recovers its transparency — et claro cernes sylvas Aquilone moveri. Virgil, Georgic 1, [to whom we must allow .the poetic license of putting **Aquilo**, the North-East, for any Northerly breeze.] But it is usually not long before the returning clouds indicate the near approach of a new supply of vapour — namque urget ab alto **Notus**, [a moist Southerly current.] Idem.

In the decline of the year the rain appears to originate, as before observed, in a somewhat different way. The great body of the atmosphere is then usually moving with some force from South-West to North-East, while the Sun is declining to the Southward. An air already turbid from beginning precipitation, is further charged, below, by an excess of evaporation from the agitation of much watery surface over which it passes. Every calm interval then affords its shower, followed by wind and evaporation again: and a succession of gales by night, and cloudy days, characterise the approach of the hibernal season. Exceptions however are found here, as in the former case; the autumnal rains being sometimes (though rarely) scanty, more inclined to frost.

It should be observed, that a current from North or South may at times move through a considerable space in the higher atmosphere, **and there be spent**; manifesting itself below only by the precipitations which it occasions: also that the prevalent wind of the winter season, the South-West, must be allowed occasionally the same operation on an intruding vaporous current from the South-East, as has been ascribed to the more direct antagonist of the latter, the North-West.

ANNUAL RAIN FOR THE YEARS FROM 1820 TO 1831; WITH REMARKS.

The following are the Annual amounts of Rain, for the twelve years from 1820 to 1831 included. The materials for the calculation are the amounts of Rain in the Gauge at the Laboratory, Stratford, exhibited in the Third volume. The mean Temperatures of the several years are annexed.

Year		Rain		Mean Temp.
1820	………..	23.66	………..	47.95
1821	………..	31.36	………..	49.81
1822	………..	22.77	………..	51.40
1823	………..	24.03	………..	48.33
1824	………..	31.49	………..	49.71
1825	………..	21.88	………..	50.89
1826	………..	22.56	………..	51.31
1827	………..	24.19	………..	50.39
1828	………..	28.66	………..	52.10
1829	………..	24.60	………..	47.45
1830	………..	26.52	………..	48.85
1831	………..	29.29	………..	51.24
Averages		25.92		49.95

The Rain was also measured at **Tottenham**, during the years 1821 and 1822; and I think it proper I should here give the Monthly amounts of this gauge in comparison, that the Reader may be enabled to judge for himself in what manner, and to what extent, the Annual Average may be affected by a distance of six or seven miles from the Thames, in the direction towards the more hilly parts of the country.

Mo.	1821		1822		Tottenham	
	Lab.	Tott.	Lab.	Tott.	+ or	-
1	2.89	2.98	0.62	0.70	0.17	
2	0.31	0.08	0.82	0.95		0.10
3	2.92	3.44	1.60	1.39	0.31	
4	1.52	1.92	2.44	2.63	0.59	
5	1.84	2.18	1.58	1.56	0.32	
6	2.22	1.62	1.19	1.00		0.79
7	2.82	2.54	3.23	2.67		0.84
8	2.16	2.60	1.39	1.49	0.54	
9	2.65	2.60	1.46	1.03		0.48
10	2.51	3.08	3.62	3.93	0.88	
11	4.67	5.15	3.46	3.72	0.74	
12	4.85	4.95	1.36	2.06	0.80	
	31.36	33.13	22.77	23.13	4.35	2.21

The fifth and sixth columns show the quantities by which, **on an average of a dry and a wet year**, the rain at Tottenham exceeded or fell short, in each month, of that at Stratford. And it should seem, by what is here exhibited, that the Annual Rain, in wet years more especially, receives a perceptible increase, by a change of the station of but a few miles, towards a more hilly one; a result which might have been expected.

Having made the same comparison on the Results for twelve Lunar periods, comprehended within the year 1817, the Rain at Tottenham is found to be 22.16 inches, and that at Stratford 22.13 inches, (upon the whole year 24.77 in. and 25.39 in. respectively,) the amounts measured at the respective stations differing, in some instances, from half an inch to a whole inch for the same period. **The law of compensation which pervades the science in its other branches thus appears here also**.

The **Mean Annual Rain**, then deduced from these twelve years observations, is 25.92 inches. The general average already given at p.65, deduced from twenty-three years' results, (part of which had been subjected to an estimated addition for the height of the gauge above the ground) is 25.179 inches. The average of the series of years, from 1797 to 1831, the respective amounts of which are given in this work, is 25.426 inches. The Mean Annual Rain for London, according to my observations, may therefore still be stated in round numbers as **Twenty-five inches**. We shall, perhaps, hereafter, be furnished with a sufficient set of observations with comparable gauges, in different plates around the Metropolis, to settle the amount with greater precision, for the whole district. And it is probable that, in this view of the subject, twenty-six inches will be found nearer the truth.

With respect to **wet and dry years**, and the agreement between these and the Annual Temperature, formerly mentioned, I may observe, that although the years 1822, 1825, 1826, and 1827, may be pronounced **warm and dry**; yet, on the other hand, 1828 and 1831 are **warm and wet**; and 1820 and 1829 **cold and dry**. The series here presented contains, properly speaking, no year that is cold and wet. Thus the Rule of a connexion between a high Temperature and dryness, on the whole year, may be left to abide the result of a further trial, to be carried on through future seasons.

The **greatest** depths of Rain fell in 1821 and 1824, in connexion with an average annual temperature; and in 1831, which had a high Mean. The least in 1822, 1825, and 1826, all of which were **warm**.

Having founded my former estimate, in part, on the Results of Observations made at Somerset House on account of the Royal Society, it becomes needful for me, here, to make some further remarks on the conduct of **our Register** there (since, as a Fellow, I must take, I suppose, my share of the responsibility,) to the present time.

It will he seen, (at p.65 of this volume,) that from 1797 to 1806, this Register gave a series of Annual totals, which, (corrected for the elevation of the gauge, by a rule deduced from careful experiments, made at Plaistow by myself,) made the Annual average 25.577 inches. From this average, that of the seventeen years preceding 1797 differs by little more than half an inch. I have there likewise said, that the average of the years following, to 1809 included, agrees sufficiently with the former; also that from 1810, (of which we have no account in the Register,) this department of the Observations has been subject to inaccuracies and defects, not consequent on the mere elevation of the gauge, which, I am sorry to add, still continue to appear in it. In other parts of the Observations there has been a great reformation; but the improvement in these will serve only, as regards the Rain, to recommend a long series of errors.

One of the first things that a man of plain good sense, who desired to know something from so good authority about the seasons, would look into, is undoubted this, of the quantities of Rain fallen in different seasons. But from what is exhibited in the Transactions of late years, he would derive nothing but misinformation.

Let us try a few examples:

Year	Royal S.	At the ground.	Laboratory.
1823	13.857 in.	18.307 in.	24.03 in.
1824	20.695	27.347	31.49
1825	13.933	18.411	21.88
1826	Left imperfect		
1827	9.928	13.119	24.19

The first column gives the Result as summed up from the amounts in the Register — correctly enough, but from defective **data** — the second, the same, as it would have been at the ground — the third, the actual Rain at or near the ground, at Stratford.

It appears that in the Society's results there is a deficiency, from some cause, varying from a seventh to a half of the quantity that should appear. And in many instances, where Rain is noted in the Marginal remarks, it is wanting in the Table; which is sometimes the case for a whole Month together. I suspect that an incurable defect in the apparatus has discouraged the observer from paying the necessary attention to the entries: and in such circumstances, it seems worse than trifling for the Society to insert in its Register such results, to be gravely quoted by a Vice-President, in a paper on Meteorology; as valid. I long since made an offer to the Council of the Society, in a Committee of the Fellows (appointed at a regular meeting,) at which both Sir H. Davy and Dr. Young were present, to assist in providing a remedy for this glaring defect in a part of its operations: but it was never cordially accepted.

The average Annual rain of the ten years (from 1820 to 1830, omitting 1826) is 17.615 in. which corrected for the elevation of the gauge gives 23.277 — **a quantity falling below the real average of the district by more than two inches**. It may be said that probably other causes than such as have been stated, and those peculiar to a great city, contribute to this deficiency. It would be very satisfactory to be able to appreciate the action of such causes, and their annual share of effect — but until an Instrument, which is understood to be that of so respectable a Scientific corporation, and the indications of which they have so long been in the habit of publishing, shall be deemed worthy of **daily use** when Rain is falling, we shall in vain expect from this quarter the **data** needful even for the construction of the problem.

I have found the Annual Rain at the village of **Ackworth** in Yorkshire, during the ten years I have resided chiefly there, to agree very nearly with that of London. The last year, **Stratford** gave 29.29 in. and **Ackworth** 28.37 in.: in other years the latter has somewhat exceeded. I shall probably recur to the comparison of the two hereafter.

AVERAGES AND PERIODS OF RAIN FURTHER CONSIDERED.
THE MONTHLY AVERAGES OF RAIN EXTENDED TO A PERIOD OF THIRTY-FOUR YEARS.

The Monthly proportions of Rain for the Climate, given with a Curve in p.70, are founded on an average of twenty years, extending from 1797 to 1816; and corrected, so far as, was needful, for the elevation of the gauge. I shall now proceed to exhibit these for two periods, the one prior, the other subsequent to 1816, which I regarded, in treating of the Temperature, as natural periods of revolution in the seasons of our climate. Lastly, I shall present to the Reader the longest averages of our Rain I am at present able to produce, attended with satisfactory **data**; to wit, those of **thirty-four years**, from 1797 to 1830.

The following Table shows the Monthly proportions of Rain, together with the average number of days on which it rained in each month, for the period set down at the head of the columns.

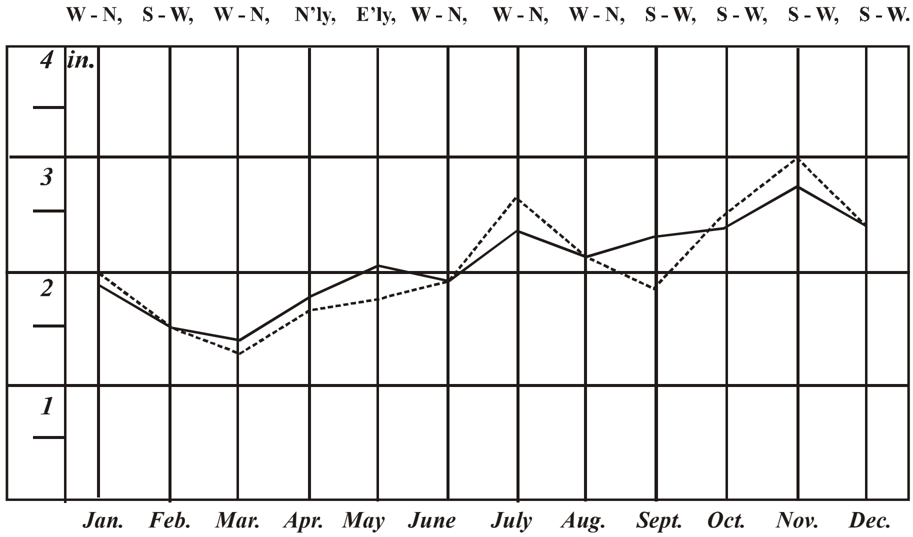
Month		Period & quantity 1807-1816		Days & pts.	Period & quantity 1817-23		Days & pts.
1	Jan.	1.907 in.	….	14,4	2.31 in.	….	16,3
2	Feb.	1.645	….	15,8	1.85	….	14,3
3	Mar.	1.542	….	12,7	1.79	….	16,7
4	Apr.	1.719	….	14,0	1.95	….	15,7
5	May	2.036	….	15,8	2.23	….	14,6
6	June	1.964	….	11,8	2.23	….	11,9
7	July	2.592	….	16,1	2.34	….	13,0
8	Aug.	2.134	….	16,3	1.45	….	12,6
9	Sept.	1.644	….	12,3	2.11	….	13,0
10	Oct.	2.872	….	16,2	2.38	….	16,1
11	Nov.	2.637	….	15,	2.59	….	16,0
12	Dec.	2.489	….	17,7	2.57	….	15,4
Totals		25.181	Av.	14,84	T. 25.80	Av.	14,63

The comparison about to be made between these periods has not been extended further in Averages, because the **Decade** of years from 1824 to 1833 is still running; but I shall have occasion to make some reference to it in detail. The principal differences that here show themselves, between the Decade and the Septenary, in respect of Rain, are these. In the Septenary the Rain increases somewhat, both in amount and on the whole in frequency, in the first four months of the year. The Fifth, Seventh, and Eighth are drier, by both standards; indicating the finer Spring and Summer weather which it brings. September is wetter in the Septenary; and December, without losing in amount of rain, shows a greater proportion of fair weather. The general features of agreement between the two, in respect of quantities and frequency of Rain, can scarcely have failed attract the attention of the experienced Reader.

The materials for these Averages will be found in detail in the General Tables D, D2, D3, and H, belonging to the Head **Rain**, at the end of this volume. If the reader inclines to take up these Tables and try the comparison further, especially between the two Averages of seven years at the foot of D2 and D3, he will perceive the Rain to be quitting the Winter, in which it was remarked as wetter in the Septenary, and returning to the parts which in that were more fair: and this will be found especially the case in the Eighth and Ninth months,- a difference which most of all affects the labours of the husbandman, and the condition of his crops when harvested.

I may probably resume this comparison, should life and health be afforded me, (or cause it to be made by another hand,) after the expiration of next year, in connexion with various other subjects of enquiry, connected with the natural periods, which will then present themselves.

FIG. 21.



The Result of the Averages on thirty-four years, comprehending the length of two natural Revolutions of the seasons, (though beginning and terminating out of course,) is particularly satisfactory. The **character** of the curve, (See Fig. 21,) representing these Monthly Averages on twenty years, is preserved, here, in a manner which fully confirms what has been advanced on the subject, in the, space from page 69 to 71 of this volume; and which matter I shall therefore not need here to treat over again in detail; upon the evidence of the new **data**. I have preferred leaving the former curve in this figure, in a dotted line, to facilitate the comparison. The amounts from which it was constructed are as follows: the number of days on which any rain fell, and the prevalent wind for each month are annexed, as before, but from 1807 only.

AVERAGE MONTHLY RAIN FOR THIRTY-FOUR YEARS, WITH THE PREVALENT WINDS FOR EACH MONTH.

1797-1830		Rain in inches		Days & Parts.	Winds.
1	Jan.	1.90		14.7	W—N
2	Feb.	1.49		14.9	S—W
3	Mar.	1.39		13.8	W—N
4	Apr.	1.84		15.0	N'ly
5	May	2.00		14.5	E'ly
6	June	1.94		12.3	W—N
7	July	2.55		14.4	W—N
8	Aug.	2.15		15.4	W—N
9	Sept.	2.29		13.8	S—W
10	Oct.	2.41		15.1	S—W
11	Nov.	2.79		15.0	S—W
12	Dec.	2.38		16.5	S—W
Totals		25.13	Av.	14.6	

I shall conclude this head of **Rain** with an Essay, which I wrote nearly thirty years ago, on the proximate cause of the fall of rain, and on the principle of local showers depending on Electrical action in the atmosphere; which may serve to explain more clearly some parts of the Essay on the Modifications of Clouds, relating to that subject.

ON THE PROXIMATE CAUSE OF RAIN, AND ON ATMOSPHERIC ELECTRICITY;

Being an Essay read before the Askesian Society, in or about the year 1804.

IN a former Essay I gave the Society some intimations of the supposed action of the Electric fluid in the process of Rain, and quoted on this occasion the opinion of **Kirwan**: and the more valuable conclusions (because deduced from experiment) of **Cavallo** and **Read**. Having since more attentively examined, and indeed analysed, the two years' Observations of the latter, as well as verified some important facts with a similar apparatus of my own, I am prepared to state the results. That these should amount to a compleat hypothesis can scarcely be expected in the present imperfect state of Meteorology. Yet this imperfection, in point of extensive and well-directed Observations, seems to call for the aid of every fact, and every conclusion immediately deducible therefrom, that can be thrown into the common stock, for the use of the few who really make that science an object of study. I may add, in justice to **Read**, that his unparalleled industry as an observer, has materially enriched the science; and his diary constitutes a treasure not at all the less valuable, on account of the absence of plausible attempts to connect and account for the phenomena it relates. I hope we may regard him as an impartial historian, who had no system to support which might throw a false colour over his views of things.

The phenomena of Lightning and Thunder are familiar to all of us. After an accumulation of clouds to a certain degree of density, and the approach of these clouds towards the earth, we see a stroke between the two, attended with precisely the same character as the explosion of a charged electrical jar, or battery; though incomparably more vast in extent, and therefore more loud and luminous. After one or more explosions, follows heavy and plentiful rain, and in general a total change in the character of the weather. From extreme heat and dryness, it passes to a moist cold and hazy state; and whereas, before the storm, we saw heavy clouds formed from day to day, which disappeared in the evening without Rain, now, the Atmosphere is become so impatient (if we may so use the word) of cloud, that it will support nothing but a thin sheet, which is almost continually dripping.

In spite of these so evident indications of the purposes answered by Electricity in the Economy of Nature, it is usual with all but those who have studied the subject, to speak of a Thunder Storm as a mere accident, arising from a particular state of the air; and of Rain as a simple deposition of Water, by a change of capacity in its solvent the atmosphere; while the proximate causes of Rain and of fair weather, (those which determine the periods of the former, and without which no such thing as a shower could possibly exist,) seem to obtain little or no attention, even from writers who profess to explain the constitution of the atmosphere. A due attention to the phenomena of **Atmospheric Electricity** would remove this indifference, and assign its due rank in philosophical systems to one of the most universally diffused, most active and useful fluids in nature.

I shall first notice the state of Electricity, when no Clouds are present, or in what we term a **clear air**. This, all observers agree to be **positive**, when any can be obtained; and the collection of it seems to become more difficult, in proportion, to the absence of suspended **water**, (not **vapour**, for that is a **gas**, and therefore a non-conductor.) Hence, says **Read**, "The moments of its greatest force that of the daily electric charge, are about two or three hours after the **rising**, and some time before and after the **setting** of the sun: those when it is weakest, are from mid-day to about four p.m., at which time (we may add) evaporation is most perfect, and the lower atmosphere most free from **diffused water**, which, for brevity, I shall hereafter denominate **haze**. But as haze, diffused to a certain degree of density, may assist our instruments in collecting a charge, by facilitating the passage of the fluid to the points, so in a much greater quantity it may prevent it by destroying their insulation.

Of the state of the Electricity in Clouds, we are much less conclusively informed. One important fact, however, stated by **Cavallo** and **Read**, I have repeatedly verified. The **Stratus** is always charged positively, and sometimes affords sparks through the medium of the insulated rod. Now, when this cloud prevails, there is usually a very serene atmosphere above it, and the lower surface of the cloud is also in contact with the earth. To suppose that the charge is derived from the latter, would be to violate the laws of Electricity which require all communication with the earth, to he suspended in order that a body may be charged. On the other hand, there is no appearance of its being superinduced by a negative state above. In fact, the clear atmosphere, in the intervals between the recurrence of the cloud, is found also positive. We have, therefore, sufficient proof of the fact, that a cloud formed in a positive atmosphere acquires therefrom a **positive** charge, of greater intensity than that of the atmosphere itself. If this be effected merely by its conducting power, (or in other words, by superior affinity to the Electric fluid,) it will follow that Water, collected from air, in whatsoever state, will become positively charged with regard to such air.

It appears also that Clouds are, to a certain degree, retentive of their charge, and that even the contact of some part with the earth does not speedily deprive the whole mass of it.

The signs of Electricity given by the higher Modifications, either through the medium of the rod or the kite, **without Rain**, are of very rare occurrence. With my own apparatus, which indeed wants the advantage of rising ground, I have never got any from the many dense clouds that I have watched in passing. According to Cavallo and Read, however, they are sometimes positive, sometimes negative, and oftener effect the apparatus influentially than by communication. It is obvious that all those Clouds which appear above the range of the Cumulus must be out of the reach of such examination. In a mountainous country one might hope to get a charge with ease, from the denser modifications; but I do not find that much has been done in this way.

It is from **Rain**, **Hail**, and **Snow** that Atmospheric Electricity is usually collected; and when we consider the remarkable fact, that only about five cases of Rain in one hundred gave no signs by the rod, we shall see that there is ample proof of the necessary connexion of Electricity with Rain and a sufficient in inducement to ingenious persons to investigate the nature of this connexion. I shall first give a few of Read's observations at length, and then a summary view of the results obtained by my examination of the whole of them. The notations of the **Wind Barometer** and **Thermometer**, made at nine a.m. are also extracted, as I find them in his "Journal of Atmospheric Electricity, &c." in Philo. Trans. Vols. 81, 82.

"1789, July 20. Wind NW., B. 29.10 in. Th. 54° — Three o'clock p.m. I saw a Thunder Storm approaching. While the storm remained at a considerable distance, the rod was very highly charged with **negative** Electricity, and continued so for three quarters of an hour, during which distant thunder was heard. Sometimes the pith balls (suspended from the wire connected with the rod) were affected with a waving, at others, with a jerking motion. [E]

"The wind now shifted to the SE, a heavy Rain came on, and the Electricity changed to positive."

The author then describes the "very grand" appearances of his apparatus when in high charge; which were terminated by a clap of thunder. There were **nine** alternations of the charge during its continuance, from **neg**. to **pos**. then to **neg**. and so on.

Some of the Rain being caught in a glass bowl on an insulated stand, not only gave electric signs when thus insulated, but retained its charge near ten minutes in the house. [D]

Aug. 31. NW., B. 29.75 in. T. 62° — **Negative** signs "from a shower, the drops of which were very large. The Electricity soon changed to positive. Though every circumstance was favourable, yet the charge in the rod was but weak. My suspicions led me to try the state of the uppermost end of the rod, which was found to be in an opposite state to the lower, and the middle non-electric." Consequently this was not a **charge**, but an **influential** effect only.

Sept. 1. SE., B. 29.62, T. 58°.— Weak **neg**. signs.

Sept. 2. — From a shower in the afternoon the same, though there had been pos. sparks at 9 a.m.

September 3. S., B. 29.47 in. T. 69°.— positive sparks a.m. "p.m. a strong gale of Wind. I now saw thunder-clouds forming at a great height. Half after five — appearances were dreadful; in five minutes the wind became a storm from SE. This storm of wind (for there was but little rain,) carried the huge black clouds to the NW. I saw abundance of red lightning a little above the horizon, and I once heard thunder. The rod before the storm, was **pos**. but by it was changed to **neg**. and continued so during the whole time. The Electricity often varied in strength." [E]

There were thunder-storms from four to six this day, at Amersham, (which it appears the Author saw and heard,) and near **Packington** in **Warwickshire**, distant about one hundred miles.

1790, June 11.—	N.	B. 29.90	T. 65°	signs **pos.**
12.—	N.	30.00	59°	**pos.**
13.—	NE.	30.29	60°	**pos.**
14.—	NE.	30.30	64°	**pos.**
15.—	NE.	30.30	69°	**pos.**
16.—	N.	30.23	54°	**pos.**

The weather these six days serene and clear: the Electricity variable: greatest charge caused the pith balls to diverge seven-tenths of an inch.

June 17. E., B. 30.10, T. 61°.— "This day has been dark and hazy. 9 p.m. wind S.: a prodigious large cloud approached the rod, and a little rain fell; yet there were no signs of Electricity in the rod. In a few minutes after this I was surprised by hearing the bell ring. [A bell connected with the ground was attached to the apparatus, with an insulated ball hung between it and the terminating brass knob. Consequently, when the author was out of the room he might be **rung for** by a charge, on its arrival.] I ran to the apparatus, and found it highly charged negatively. When the main bulk of the cloud arrived over the rod its electricity changed to a strong positive, and in a quarter of an hour the Rain and Electricity ceased together. [B]

27. N., B. 29.96, T. 61°.— a.m. strong sparks **pos**. "Four o'clock p.m. I saw heavy clouds forming, and as they came nearer the rod became more powerfully electrified **negatively**. It now began to rain, by which the rod became intensely electrified indeed. Many dense sparks now struck through the air, between the bell and the brass ball, with a loud report for so small an opening of two inches only. There were six changes of Electricity in two hours." [D]

28th, 29th, 36th. — Moderate positive signs.

July 1. W., B. 29.83, T. 66°.— a.m. small sparks **pos**. p.m. **neg**.

2. W., B. 29.77, T. 63°.— a.m. strong sparks **pos**. "Half after twelve o'clock, p.m. a sudden gust of wind, followed by a shower of Rain, **pos**. with small sparks: soon afterwards **neg**. Near four p.m. a very large black cloud passed over the rod, and let fall a little rain, mixed with hail, by which the rod became highly electrified negatively. The bell now rang briskly, till a flash of lightning and instant crack of thunder happened, **which occasioned a sudden change to positive**: then the bell struck up again as brisk as before. The rod has been charged ten hours without intermission this day." [A]

July 15 to Aug. 3. Prevailing winds SW and NW., Bar. ranged from 29.75. to 30.15, Therm. from 57° to 69°.— "The weather these nineteen days, has been generally moderate, and the Electricity, (which has been uniformly **pos**.) at no time sufficiently strong to afford visible sparks."

Aug. 3. — "A heavy cloudy morning; but fair. Half after one, p.m. a heavy shower of Rain fell; by which the rod became highly charged with **neg**. Electricity. When the cloud was fully over the rod, the Electricity changed to **pos**.; and when it, had passed the zenith, the electricity changed again to **neg**. [C]

After this, positive Electricity prevailed again, including, a few showers on the 16th, (some of them not sensibly electrified, others **pos**.; but too weakly so to be distinguishable from that of the Atmosphere,) until the 21st of this month, (wind S., B. 29.75, T. 77°.) when the apparatus in the morning gave strong sparks **pos**.; but at five p.m. fell some large drops of Rain, by which the rod was highly charged **pos**. the bell rang briskly about five minutes; then stopped, and the Electricity of the rod became **neg**. The Rain now ceased, and the sky cleared up, and the charge decreased considerably; ending as it had begun, **pos**.

Sept. 2.— These phenomena were repeated. [A]

3. W., 13. 29.50, T. 58°.— a.m. strong sparks **pos**. "Near one o'clock, p.m. the charge in the rod was **neg**. I then saw thunder-clouds forming in the S and N. Some large drops of Rain now fell, by which the charge became very strong." After the cloud in the N had gone by W into the S, the charge (which in the mean time had decreased,) ended **neg**. [E]

Nov. 10 to 19.— Sharp dark weather, and a dry Easterly wind, with a weak Electricity **pos**.

19. Wind S., B. 29.24. T. 47°.— "The severe Easterly wind is now gone, and a more intense Atmospheric Electricity is returned. Nine o'clock a.m. a large black cloud passed over the rod, and a moderate shower of Rain fell, by which the rod was rather strongly electrified **neg**. This shower lasted one hour, and **near the middle of it** the Electricity changed to a strong **pos**.: after this the Electricity ended, as it had begun, **neg**." [C]

30.— **Small sparks**, **pos**. from a shower of **Snow**.

1791. Feb. 19. NE., B. 29.40. T. 37°.— "Five o'clock a.m. a dark cloudy morning, with some small Rain, by which the rod became rather strongly electrified **pos**. During the passage of one low cloud, the charge in the rod changed five times; **all of which changes I have reason to think were only influentially effected**: 20th a.m. small sparks **pos**. rainy dark weather. In the afternoon the charge became **neg**. and remained so full three hours.

March 3 to 20.— Serene fair weather, and the nights generally frosty. The Electricity **constant**, but too weak to afford visible. sparks, pos.

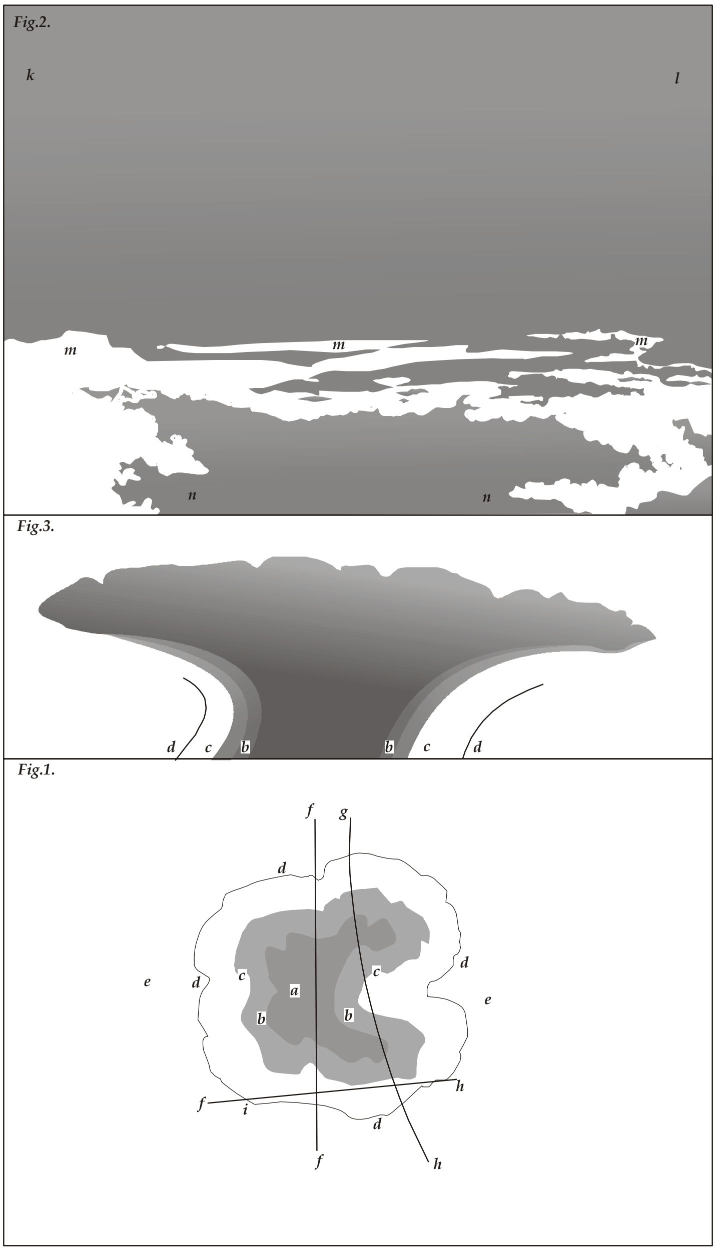
20. W. [it had been SW before] B. 29.68. T. 46°.— "This morning fell a warm drizzling Rain, which seems to have acted like a charm on the late constant electrisation of the Atmosphere: for I find it so weakly electrified, since the Rain fell, that I was obliged to connect with the rod a lighted torch, to ascertain the kind." [This was **neg**. but I suspect the torch might afford it. I much doubt the soundness of such a mode of procuring the Electric signs from the air. The intention was to dissipate the moisture in the neighbourhood of the points — but this must likewise affect the state of Electricity.]

21. NW., B. 29.15. T. 44°.— "Four o'clock this morning, a severe storm of Wind and Rain — highly electrified **pos**. Four o'clock p.m. some Rain fell mixed with Snow, which lasted near one hour. During this time, the rod was most powerfully electrified **pos**. [B] I counted seventeen spontaneous **explosions**, between the brass ball and bell. Half-after five, a second shower of Rain, Hail, and Snow; which lasted half an hour, attended with uncommon darkness. During about half this time the charge in the rod was as strong as possible; for the fluid almost streamed between the ball and bell. The latter very high charge was neg. [D] There were four changes, but all gradual." 22, 23, 24, 25: constantly positive.

26. S., B. 29.85. T. 46°.— "Half-after 9 a.m. fell some Rain, by which the rod became electrified **neg**. The wind now became N. attended with showers of Rain, the rest of the day; **all of them moderately electrified NEGATIVELY**.

April 23. SW., B. 29.23. T. 54°.— Half-after 12 p.m. an extensive black cloud, without any breaks in it, approached the rod, by which it became strongly electrified **negatively**; and in the space of twelve minutes a most awful darkness filled the Atmosphere, and some Rain fell mixed with **hail**. The charge now became **positive**; and for the space of ten minutes, was as strong as it possibly could be: for I now counted 172 spontaneous explosions between the brass ball and the bell. When the explosive sparks ceased, the Electricity of the rod changed, and ended (as it had begun) **neg**. A little after five o'clock, fell a heavy shower of Rain, and a **second** strong charge in the rod succeeded; attended with **three** gradual changes of the kind."

Plate 3. Illustrative of the Electricity of Rain.



From an attentive examination of Read's Observations I have been able to deduce the following general results

1. **The positive Electricity, common to fair weather, often yields to a negative state before Rain**.
2. **In general, the Rain that first falls, after a depression of the Barometer, is NEGATIVE**.
3. **Above forty cases of Rain in one hundred give negative** Electricity; although the state of the Atmosphere is **positive**, before and afterwards.
4. **Positive Rain in a positive Atmosphere occurs more rarely**: perhaps fifteen times in one hundred.
5. **Snow and Hail, unmixed with Rain, are positive, almost without exception**.
6. **Nearly forty cases of Rain in one hundred affected the apparatus with both kinds** of Electricity; sometimes with an interval, in which no Rain fell: and so, that a positive shower was succeeded by a negative; and *vice versa*: at others, the two kinds alternately took place during the same shower; and, it should seem, **with a space of non-electric Rain between them**.

The regularity with which the latter phenomena sometimes occurred, seems to furnish a clew for explaining some of the preceding cases; and indeed for constructing a hypothesis of local Rain. I shall submit to the consideration of the Society my conjectures, in the confidence of their meeting with a candid examination; and on this account I ought to add, that the latter part of my investigation of Read's Journal has been performed with this supposed clew in my hands; that I have met with some facts to which it is not applicable; and am therefore willing to distrust its guidance, except in those points where it applies directly to the phenomena. The members may do well to compare what I shall advance with the Journal at large; since objections may occur to them, which have escaped me.

Let Fig. 1 in the plate opposite represent the area on which a local shower falls: **a.** being a certain portion in the centre, in which the Rain is charged **pos**:- **b.b**. a surrounding portion, in which the **pos**. charge terminates; and which may be considered as occupied by non-electric Rain, **c.c.** the remainder of the area, surrounding the two former portions, and occupied by a **neg**. charge; which also extends into the surrounding Atmosphere **e.e.** to a distance proportioned to the intensity of the central positive charge. The non-electric boundary of the negative charge is represented by the line **d.d.d.d.** Outside this line, the Atmosphere is supposed positive; as usual when free from clouds.

In a shower so constituted, the Electric signs, obtained by observations made in a single and fixed station (as Read's were) would be subject to the following variations:

1. The Central area remaining the whole time over the instrument, the observation would be **pos**. and, 2, the circumferential area doing the same, it would be **neg**. Many cases in Read will be thus explained, and it is favourable to the hypothesis that the **pos**. observations are to the **neg**. nearly as 1 to 3: but on the other hand this does not account for the fact, of several showers being negative in succession; nor for the relation which seems to obtain between depressions of the Barometer and negative Rain.

3. The Rain beginning with the central area over the instrument, and ending with the circumferential, the observation would be first **pos**. then (after an intermission of the electric signs) — **neg**. See the Cases marked A.

4. The circumference being first examined, and the Rain ceasing by expenditure during the charge from the Centre, the order would be the reverse of 3. See the Cases B.

5. The cloud passing over in the zenith of the apparatus, and the latter being considered as describing under it the line **f.f.**, all the appearances would agree with the Cases marked C.

6. But the line which the apparatus may be considered as describing under the cloud, in consequence of irregularities either in the motion or form of the latter, may resemble the curve **g.h.**: and after having entered the shower, or commenced within it, may pass and repass the non-electric boundary, several times during its [the Rain's] continuance. It may also happen to commence, or to terminate, in the latter. This will serve to explain the cases marked D: with many others of the same description.

7. It frequently happens that the apparatus is charged, in consequence of rain falling at such a distance that not even the skirts of the shower come over it. This is particularly the case in thunder-storms; and the phenomena are such as ought to take place, according to the hypothesis, when the centre of the mass of clouds and Rain (which electrically considered form one aggregate) passes at a certain distance from, and parallel to, the line **f.h.**: on which we now suppose the apparatus to be, The latter then loses its **pos**. charge at **i.** and presently acquires a **neg**. which becomes more intense, as the Rod enters further into the negative area, and dies away as it quits it, till at **h.** it becomes extinct. See the Cases marked E.

8. If the station of the observer, during a thunder-storm, happened to be in any part of the circle **d.d.d.d**, he might be unable (if the time devoted to the observation was short) to obtain any signs whatsoever from his apparatus: although he might both see and hear the successive discharges in the horizon. I have witnessed such an occurrence myself: and I suspect that what **Reid** has noted, under June 22, 1790, is from the same cause. The centre of the storm, in this case, appears to have been about Salisbury, distant 80 miles. When we consider the elevation which was necessary to render even the extremity of this storm **visible** at Knightsbridge, we shall not find this distance too great for the semi-diameter of the total area, in which its effects might be **sensible** with a good instrument.

The Cases to which these explanations seem clearly applicable, are those marked C and E. In the remainder, there is room for correction by future observations; which would be far the most instructive, if conducted in concert, by several persons at different stations, within the compass of a few square miles. It will be readily seen, that I have made the accumulation of positive Electricity, in a certain portion of the Atmosphere, **the basis of the whole system**. The remainder follows, as a necessary consequence from the known laws of Electricity. But the production of positive Electricity is not necessarily confined to the centre of an aggregate of clouds; nor its effects to a lateral direction only. Cases may occur, in which one extremity of the aggregate may positive, and the other in consequence negative: there may be positive Electricity in a certain **stratum** of the Atmosphere, and from hence may result a negative counter-charge in a contiguous stratum, **above or below**. In continued Rain, such a distribution most probably obtains; but we must have more observations to be able to prove it. Our present object is, to show how a local shower is organized; and, if possible, **to trace its immediate origin to Electrical causes**: for it is in vain that the principles of Chemistry alone are appealed to in this case. Let us see, therefore, how it happens that the centre of a shower is often strongly **positive**.

The Clouds originate from vapour, which is first formed **in contact** with the earth. It is not, therefore, then electrified, except the surface on which it is formed be at the time **superinduced**. But the latter is the proper effect of impending clouds: and although a truly electrised vapour may be thus formed, and being condensed may constitute a part of the system of clouds in a thunder-storm, yet our present enquiry goes further: we want to account for the **superinducing charge**.

It would be a difficult undertaking to ascertain, by experiment, the Electrical state of vapour, and of the surface on which it originates **in the natural process**. Experiments have been made on insulated substances, at high temperatures, the results of which, even if more conclusive, would be quite inapplicable to this case. I shall therefore offer some conjectures on the origin of Atmospheric Electricity, which will, in the first instance, proceed on the supposition, that **vapour is originally non-electrised**.

A body in order to be charged must be first **insulated**: and the charge will continue during **perfect** insulation; but the latter seems unattainable. There is always a small degree of conducting power in the very Atmosphere, when at the maximum of dryness; and this is greatly augmented by what is called **moisture**: by which I understand diffused and suspended (not elastic and gaseous) Water.

We can scarcely imagine a body more perfectly **insulated**, than the first particle of water, which, separating from vapour that has ascended into the higher Atmosphere, begins to obey the law of gravity. There are two sources from whence such a particle may obtain an Electric charge, *viz.* the surrounding **air**, and the vapour out of which it was formed: and which **may** (though in itself non-electric) afford to the water, now reduced many hundred fold in volume, **a real positive charge**.

Appearances likewise are much in favour of the opinion that the precipitation of water, in the higher Atmosphere, is sometimes effected by a double affinity; in which Electric air and gaseous water are mutually decomposed: the former seizing the **Caloric**, [Caloric had become, when this essay was read, a conventional term with this society, for the matter or cause of heat] the latter the **Electric fluid**.

At all events, we are certain of the fact, **that Clouds are insulated and charged conductors**. **Franklin** supposed, that clouds arising from the sea, were positive, those from the land, negative; and that their encounters in the air were the cause of thunder-storms. **Kirwan** and others go a little further, and say that a positive cloud (become such in the way I have stated) may affect another with a negative state by its approach, and thus attract it to form Rain. But all these explanations fall short of the phenomena. Had this been all the process, we should have known nothing of the Electricity of **Rain**: for a negative and a positive cloud would unite in those proportions only which should form non-electric Rain. In addition, therefore, to the union of the oppositely charged clouds, or portions of a cloud, to form Rain, there is an immense quantity of the electric fluid conducted by the Rain, as often as it falls from the Atmosphere to the Earth, in a manner which I shall now endeavour to explain.

Let **k.l.** Fig. 2. represent a stratum of air, [in section] in which vapour is decomposing by the gradual loss of its Caloric: (the cause of this abstraction is not now the question.) The particles of Water thus separated and committed to the air subside, and arrive at the region of the upper clouds in a charged state. As soon as a sufficiently dense **stratum** of these particles is formed, we have the **superinducing cause** at the region **m.m.m.** by which the lower air may be rendered **negative**: and the accumulation of such a haze, before Rain, is not a matter of supposition only, but of long observation.

During this process, and while the negative charge is yet at a distance, there are clouds **n.n.** [in section] formed in a lower region, by the emission of vapour from the heated earth [and condensation in the colder air above.]

The effect of the superinducing charge on such clouds may produce either the **Cumulostratus**, which appears to be a **simple union** of clouds; or the **Nimbus**, which is **a union with transmission** of Electricity. The latter seems to take place, when the superior positive charge has become sufficiently intense, by the continual increase of the bed of haze, to extend its negative atmosphere quite down to the earth. The lower clouds spread [themselves] in this negative Atmosphere, and lose their charge in it. They then attract, and are attracted by, the positive haze above; and the first drops of Rain are [thus] formed. The Rain opens an immediate communication with the Earth; the positive Electricity, which before rendered the particles buoyant, **streams down along with the Rain and through it**; and the shower is propagated in all directions, till the whole mass of cloud is brought into action.

The Rain may conduct in different ways; the individual drops may receive an intense charge, at the moment of their formation and during their fall through the cloud; which charge they bring to the ground, (see Read, July 20, 1789,) or the whole aggregate of floating, uniting, and falling drops, from the very summit of the cloud to the ground, may form one immense Conductor. The latter is exceedingly probable, and not inconsistent with the former, which is fact. On the supposition that a sudden local, shower **is an Atmospherical conductor with its foot on the earth**, we are able to assign a satisfactory origin and use to the spreading crown, which is frequently seen above it; and in which we may discern an arrangement, tending from every side towards the dense part where the Rain is formed, in a manner not required by the simple law of gravity. These rectilinear or hairy portions are the collecting points of the conductor, formed in the positive haze, in consequence of the destruction of the equilibrium [of its charge] which necessarily gives rise to a flow of the Electricity towards the conductor.

But we have yet to account for the negative charge in the shower; which may probably originate from the following cause. When the Rain has commenced, and a certain part of the cloud has begun to be discharged, there must ensue a horizontal (as well as a perpendicular) movement of the Electric fluid. If the shower is a solitary one — and it is only such that we are now considering — there will be no conductor in the region of the lower clouds and Rain, to receive or furnish the fluid in a horizontal direction. The central positive charge will therefore establish a proportionate negative counter-charge around it, by driving out the Electric fluid from a certain portion of the circumference into the Atmosphere. This effect may be continued in the Rain, down to the ground; and it will take place the more easily, because the skirts of the shower are falling from that part of the mass of cloud, where the union of the upper and lower strata has just been effected: and where, consequently, the drops begin to fall nearly unelectrifled. The existence of a circle of unelectrified Rain, between the positive centre and the negative circumference, needs neither proof nor explanation, as it must necessarily happen. Let Fig. 3 represent a perpendicular section of the **Nimbus** in full action; the clouds **n.n.** being now absorbed into **m**. [and surmounting the shower:] the supposed extent of the positive and negative charges, in the clouds and Rain; are marked out by the same letters as before. It should be observed that the central space contains, not merely a conductor, but a highly charged one. In cases where the Rain is simply a conductor (which probably sometimes occurs) there will be no **charge** in it; and as to the transmission, we cannot obtain further proof of it than the previous and subsequent phænomena. See **Read**, March 20, 1790.

It remains only to fulfil the present engagement, by showing wherein a local Thunder-shower differs from the one we have been examining. The only real variation from the common process, appears here to arise from the intensity of the evaporation in the lower Atmosphere. Evaporation, we know, will go on, while the surface of the earth, or the waters, possess a temperature greatly exceeding that of the mean region of the Atmosphere; although the latter should be already overcharged with vapour and so long as the lower Atmosphere continues warm and dry, it will neither permit the condensed product of this Evaporation to return in dew, nor the charge of the lower clouds to permeate it, in order to pass off into the earth. The lower clouds, therefore, retain their Electricity, and together with the haze above them continue to accumulate, till the surface of the earth, or the prominent objects upon it, become so far superinduced with **negative** Electricity, as to receive an explosive discharge. The passage of this discharge I have concluded, from observations made at different times on distant storms, to be from the centre of the Nimbus, through the most depending part of the lower surface, into the earth; as I have traced a vivid flash of light, from the very points of the **Cirri** constituting the **Crown of the Nimbus**, into the **Cumulus**, which adhered to the lower part of the latter. The formation of the Crown I have observed to take place, while the next adjacent cloud was already in the shower; and from the direction in which the Rain continued to spread, I concluded that the discharge of the respective clouds speedily followed the expansion of this superior part, in this peculiar form.

The distance requisite to enable an observer to trace this evolution of the cloud, seems too great to admit of his also seeing the line in which the discharge takes place, from the lower part of the cloud into the earth; but it is also far too **small** for another phænomenon, which sometimes occurs, and which sufficiently proves the great elevation to which the haze is propagated before the storm. When the latter occurs about sun-set, it appears by the report of a correspondent, and my own observations [in connexion,] that the reflection of the rays from the aqueous particles is perceptible in a kind of aurora, which we found in one instance to be not only visible, but conspicuous, **at the distance of more than seventy miles** from the seat of the storm.

The **first** discharge in a thunder-storm may be concluded sufficient for opening the communication with the earth, in a single cloud; and may effect the purpose of emptying that cloud. But it more frequently happens, before the storm, that many detached accumulations, or an extensive chain of large clouds, have been formed. In these cases, the extent from which the fluid was drawn for the first discharge may be too confined: there may be occasion for many subsequent ones among the clouds, to equalize their Electricities; and lastly, it appears from lord **Stanhope's** theory, that at the moment of an actual discharge from the clouds into the earth in one place, a **returning stroke** may take place from the earth into the clouds in another. Consequently the number of explosive discharges, in a thunder-storm, ought not to be admitted as an argument against the purpose for which it appears intended, *viz.* that of restoring, to the common stock in the earth, the Electricity which is accumulated in clouds, in order that these may descend in Rain.

There are many phænomena in Read's Journal, besides those detailed in the foregoing extracts, which seem to prove that a very ready communication of Electricity sometimes takes place, between distant places, at those seasons when Thunder-storms happen. There must exist, for this purpose, a **medium** of conducting power superior to that of the lower Atmosphere, and of very great extent. Such a medium we may suppose to exist, in the haze arising from vapour decomposed in the higher regions; and which, being diffused over a large tract, and communicating with the earth only in certain places, the changes which take place in any one of these are partially felt, at the same time, in the others.

OF PERIODICAL VARIATIONS.

THE Variations of the Winds and Temperature have been shown to have an intimate connexion with the Rains of our climate. There is another relation of the kind, much more generally attended to, and on which it might now be expected that I should say something; I mean, that of the Rain to the indications of the **Barometer**.

That the Barometer descends gradually before rain, and rises, during or subsequently to it, and thus indicates the return of fair weather, is matter too trite for me to enlarge on here: and that the **Mean** of the observations is higher in the dry and fair periods, (and consequently in the years in which these predominate,) than in the wet ones, is what every attentive reader must have found abundantly proved, in the Results which have been before him. The reason of this must even have become evident; and he will now scarcely need to be reminded, that the air **weighs more** when it is warmed and charged with transparent vapour by sunshine, than when, being chilled by the long nights of winter it is shrouded in stormy clouds, and undergoing continual decomposition.

But furnished only with these general notices, he will find himself at a loss to explain many of the movements of the Column: to know why it is generally high in severe frost, or with a Northeast wind; and why sometimes very low without the expected accompaniment of much rain. He will desire to account for those large sweeps which it makes occasionally, without an obvious regular connexion with the changes of wind or weather; and for its apparent stagnation at other times, about a middle point of elevation, while the most evident perturbation in the atmosphere is going on; and Rain and Thunder occur daily. Nor will the sudden depressions attending our Southerly gales, and the rapid manner in which the former level is restored after them, escape his enquiry. A clew to the chief of these difficulties is furnished by the fact, now sufficiently ascertained, that the Atmosphere is subject, like the **liquid** ocean, to the influence of the Moon's gravity, and that from this cause, operating jointly with the Sun's attractive power, it has **its tides and currents**. It was from the supposition of this, not indeed without some ground of observation, that I was induced to cast my Reports on the weather into the form of **Lunar periods**. I shall not undertake, here, to give the theory of the Lunar tides in the atmosphere. Indeed, what I have hitherto learned respecting them, appears to constitute but an imperfect glimpse of this difficult subject: which will now possibly claim the attention of men duly qualified to investigate it; to whose service the materials to be found in these Volumes (which constitute a greater store than I can pretend to use) are cheerfully dedicated. They will be extracted, however, the most readily, by those who will first condescend to go through the labour of proving, to themselves, the general correctness of the details of my progress hitherto.

INFLUENCE OF THE MOON ON THE VARIABLE PRESSURE OF THE ATMOSPHERE, ON THE TEMPERATURE, WINDS AND RAIN.

By the Moon's change of place in her orbit.

A series of observations, which I made in the year 1798, on the variations of the Barometer, in connexion with the Lunar phases, may be found, illustrated by a plate, in Tilloch's Magazine.*

In registering the movements of the Barometer at that time, I employed instead of figures a curve, traced from day to day on a graduated Chart, sold for that purpose by a copper-plate printer in London. Finding by the specimen which accompanied these blank Registers, each of which served for a month, that the Moon's phases were to be inserted where they occurred, by an appropriate sign at the top of the column for the day, I adopted the practice; not without some previous though slight information on the subject.

My observations had not proceeded far, before I perceived a coincidence of the greater **elevations** of the Barometer with the Moon's First and Third **quarters**, and of the greater **depressions** with the **New** and **Full** Moon. When the year had been completed on my charts, I gave an account of the subject to the **Askesian Society**; a select company which met every fortnight, at the house of my friend William Allen, in London, for the purpose of philosophical discussion. By this society they were favourably received and published: the substance of the paper was as follows.

In above thirty out of the fifty Lunar weeks of that year, the curve representing the movements of the Barometer changed its direction in such a way, as to he either falling, or at its minimum for the space of two weeks, under the phases of New and Full Moon; and rising, or at its maximum for the like space, under the First and Third quarters.

The remainder of the year presented exceptions sufficiently decided to forbid this coincidence being taken for a general rule. The case was sometimes indeed reversed, so that a low Barometer coincided with the Quarters, and a high one with the Full and New. And perceiving that the **rule** obtained chiefly in moderate and settled weather, and the exceptions when it was stormy, frosty, or inclined to thunder, I came to the conclusion, that the former mode of variation exhibited the regular Lunar tides; and the latter, such a mixture of tide and currents as might be expected to belong to a perturbed state of the atmosphere.

To ascertain the effect of each Lunar position, independently of the variations supposed to be produced by currents, I took the following method: The height of the column at the time of the occurrence of each phase was taken, and the separate observations falling under each class reduced to an average; which average was then compared with that of the whole of the observations thus taken.

The mean of the whole was	29.9638 in.	
Average at Full Moon	29.906	
which is less than the mean		.0578 in.
at Third Quarter	30.153	
which is more than the mean		.1892
at New Moon	29.719	
which is less than the mean		.2448
at First Quarter	29.980	
which is more than the mean		.0162

The result of each position was thus found, on the whole, to agree with the **rule**; but was by no means in proportion to its occasional manifestations. For, in the course of the first seven weeks of the year, there appeared three great elevations in the curve, the summits of which were nearly coincident with the First or Third quarter; and one of them precisely so with the Third quarter, at the

* Philo. Mag. Vol. 7, p.365, &c.

extraordinary height of 30.89 inches. The Barometer was the same from which my observations are still registered, and was in perfect order at the time. The **mean** of the season was however a very high one; so that this pyramid stood on an elevated base. On the other hand, the most remarkable depression of the year, to 28.60 in., occurred only twelve hours from the time of New Moon; and several other considerable depressions were nearly coincident with New or Full Moon.

I determined, upon this, to extend the enquiry: and I selected for the purpose the years from 1787 to 1796 inclusive, as they stood in the Register of the Royal Society. The results, obtained by the same method, were as follows.

The mean of the observations taken out		29.818 in	
Average	at Full Moon	29.7812	
	which is less than the mean		.0368 in.
	at Third Quarter	29.8823	
	which is more than the mean		.0643
	at New Moon	29.7946	
	which is less than the mean		.0234
	at First Quarter	29.8910	
	which is more than the mean		.0730

It was not to be doubted that these numbers presented a more correct scale of the effects, than could be expected from any single year's observations. Assuming therefore the elevation of 29.818 in. as the standard of comparison, I concluded that the Barometer is depressed, on an average, about a tenth of an inch by the change of the Moon's position from either quarter to the Full and New; and elevated in the same proportion by her return to the quarters. It would have been more correct to have taken for the standard the mean of the whole ten years' observations in that Register, or 28.89 inches; and to have stated the effects thus: the Barometer, on an average of ten years at London, suffers a depression of about a tenth of an inch, by the influence of New and Full Moon respectively: but at the First and Third quarters the Moon's influence is, in respect of position in her orbit, neutral; producing neither elevation nor depression in the Barometer.

Having satisfied myself as to the fact of an influence of the Moon upon the variable pressure of the atmosphere, I proceeded to draw a parallel between this case and the tides in the ocean, thus: "I suppose therefore, that the joint attraction of the Sun and Moon at New Moon, and the attraction of the Sun predominating over the Moon's weaker attraction at the Full, tend to **depress** the Barometer, by taking off from the weight of the atmosphere (its counterpoise) as they produce a high tide in the waters by taking off from their gravity: and that the attraction of the Moon, neutralized at the quarters by that of the Sun, tends to make a high Barometer, together with a low tide in the waters; by permitting each fluid to press with additional gravity upon the Earth."

An objection was then anticipated, which might arise from the circumstance of the **diurnal** tides being the most considerable in the ocean; and the weekly elevations and depressions contributing, as they proceed, but a moderate proportion to each day's tide: whereas, in the **atmosphere** of these latitudes, where the **weekly** elevations and depressions go to so large an extent, the diurnal tide is scarce perceptible. This objection was attempted to be met by some reasons, founded on the very different physical constitutions of the air and ocean; the latter being pretty uniform in density and composition; while the former is variable in these respects, and subject moreover, by the rapid changes of the temperature which it undergoes, to currents moving in different directions with much greater freedom than in the ocean. It was also stated that at Calcutta, where the weekly variation, (as in low latitudes generally,) is very small, a daily tide had been distinctly traced by the alternate elevations and depressions of the Barometer. I have also, since the date of this essay, met with strong indications of a daily tide in Registers of a much higher latitude.

This paper had in substance the following conclusion: "It will be soon enough, however, to enter upon the Theory of the Atmospherical tides, when the facts shall have been examined; and the influence of the Sun and Moon on the atmosphere established by more extensive observations. For this purpose the subject is now brought forward; and the co-operation of observers in this or other countries is requested. The coincidence, as far as hitherto observed, is an important fact; and should it be found to obtain generally, will lead to important consequences, and in the first place to a new and more satisfactory theory of the Barometer. The true reason, likewise, of the weather so frequently agreeing in its changes with those of the Moon (a coincidence which has long served to direct the predictions of the Almanac-makers) will be apparent; and the Meteorologist will avail himself of this, to form probable conjectures on the changes likely to arise for a certain time, not exceeding that which limits the operation of the known cause or causes."

Such was the state of my information on this subject twenty years ago [or in 1799]. The study of the Modifications of clouds, and the various phenomena connected with them, afterwards occupying my attention, this particular enquiry was suspended; and when, in 1806, I began to keep a regular Meteorological Journal, it was with more general views. But being still desirous of putting to the test the opinion of a Lunar tide in the Atmosphere, I was induced, as already mentioned, to digest the observations in the form which seemed to afford the greatest facility for this purpose. It remains to show how far the purpose was fulfilled.

Plate 4 exhibits, in a system of curves, the variation of the **daily mean height** of the Barometer through the **Solar year** 1806-7. These curves are constructed from the Tables II to XIV inclusive, of my Observations, but with a different arrangement of the periods. For the sake of showing more evidently the influence of New and Full Moon, the periods are here made to begin with the day of the Third quarter; which happens in this instance to be the first day of 1807. After a dotted curve therefore, giving the variation from Dec. 22, 1806, to the end of that year, the several curves **a-b**, **b-c**, &c. carry on a series of entire Lunar periods to the 21st of Dec. 1807, at **n**, where the Solar year closes.

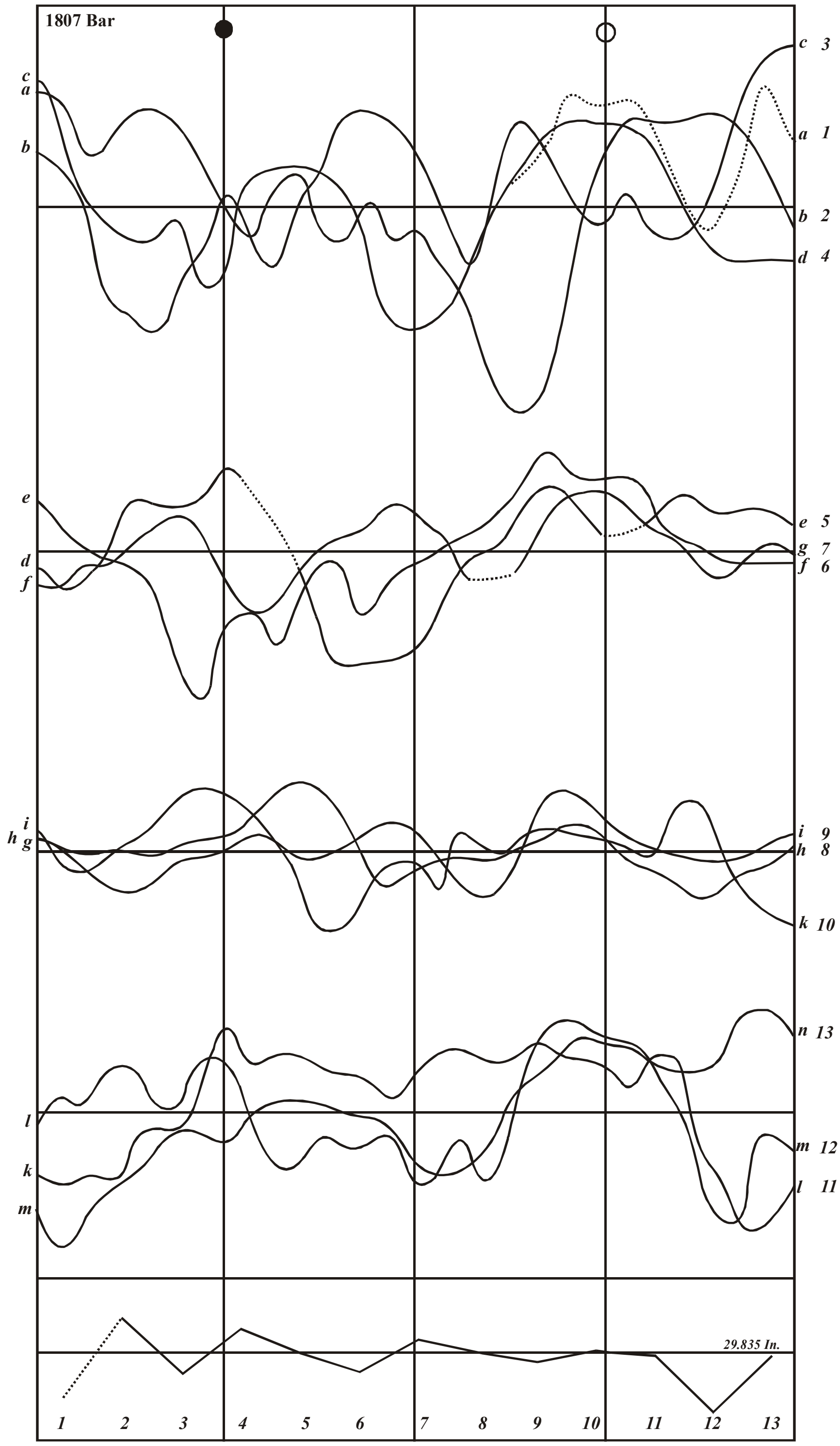
To construct these curves, the **Mean of the period** is first ascertained, and represented by a horizontal line. The relation of the **Mean of each day** to this standard line is next ascertained and marked; and a curve, carried through the points thus found, represents the variation, at its proper extent above and below the standard. In doing this, the mean of the day on which a Lunar phase happens, is made always to fall in the intersection of the curve with a perpendicular line, appropriated to that phase. Some inequalities of time in the intermediate parts of the curve, occasioned by this arrangement, are remedied where needful, by using an unequal scale of time in those parts.

By this method the curves were all obtained of an equal length, and presenting equably the relation of the Lunar points to the Barometrical mean for the period. Their tendency to rise and fall at particular intervals, and their consent or opposition in such movements, was thus also represented **independently of the absolute place of the Mean of the period, or of that of each day, in the Barometrical scale**. Each of the four horizontal lines, on which the curves are made to play, has therefore an elevation peculiar to itself, and relative only to the curve in connexion with which it is viewed: its **absolute** place in the scale of the Barometer, may be gathered from the small curve at the bottom of the diagram; where these Monthly means are laid down upon the Mean of this Solar year, which is 29.815 inches.

All this contrivance was needful in order to exhibit the distinct effect of each Lunar position, unmixed with that kind of variation from month to month, in the mean of the Barometer, which depends on the season of the year; and of which an account has been given, page 40-41, founded, it will be recollected, on a mean of several years.

To proceed now to the application — it is difficult not to be struck at first sight with the evident marks of **system**, which these curves exhibit, from the beginning to the end of the series. Were it possible to obtain, at successive equal intervals of time, the profile of the waves that roll after each other on the surface of the ocean, and were we to reduce these to a scale in like manner, it is not to be doubted that the group would present elevations and depressions **indifferently**, in all parts of the scale of time; and the intersections of the curves would soon produce confusion in the picture. But it is not so,- here the wave occurs too often in the same place, and the intermediate depressions are too regular, for us to admit, that what is called **chance** has any considerable share in producing them, or that they happen without a definite cause.

Plate 4. Exhibiting the variation of the daily mean height of the Barometer through the Solar year 1806-07.



The most prominent feature of the piece may be said to be, the nearly constant **elevation of the curve** at the approach of **Full Moon** — a very contrary result, certainly, to that found in the year 1798, and sufficient, at first view, to invalidate the partial conclusion I then came to, that the true Atmospherical tide consisted, in part, of large depressions under this quarter. These elevations, however, will be found to have their **apex**, for the most part about two days before the Full; and to be going of at the time of the phase. That they are properly connected with its approach, may be fairly inferred from the manner in which the curve No. 2 rises at this time from a great depression, as if prevented from taking an upward tendency by some unusual cause, and become more elastic by being thus strongly bent downward.

If we now turn to the **New Moon**, on the left of the plate, we perceive its approach marked, by depressions chiefly in the fore part of the year, and by elevations in the latter part. Yet the actual time of this position, or rather a day or two after it, exhibits a strong tendency in the diurnal variation to return to the Mean of the period: and the same observation applies to both the other **quarters**; which have also some peculiar **opposite** variations connected with them. The latter are conspicuous in the elevations which belong to the **Third quarter** in the first three periods, and in the depressions which attach to it in the last three; each however with an exception attached: see Nos. 4 and 13.

Enough has perhaps been pointed out, to satisfy the reader that in this year, there was a decided connexion between the Lunar positions and the mean daily movements of the Barometer: which deviated in the same direction about the same point of a Lunar revolution, whether the Mean of the season occupied the higher, lower, or middle part of the scale.

A certain relation has been long since found to obtain between the movements of the Barometer and the variations of Temperature in the atmosphere: and very early in the course of these enquiries I perceived, on tracing the curve of the diurnal mean Temperature on the same scale, and referable to the same mean line, with that of the Barometer, that the connexion was almost constant between them. It is manifested in two different ways, which may be termed conjunction and opposition; since in the one, the curve of the mean temperature accompanies (or precedes or follows by a short interval) that of the Barometer, and in the other the two vary in opposite directions, often with a very near coincidence in time. See Fig. 22, p.104.

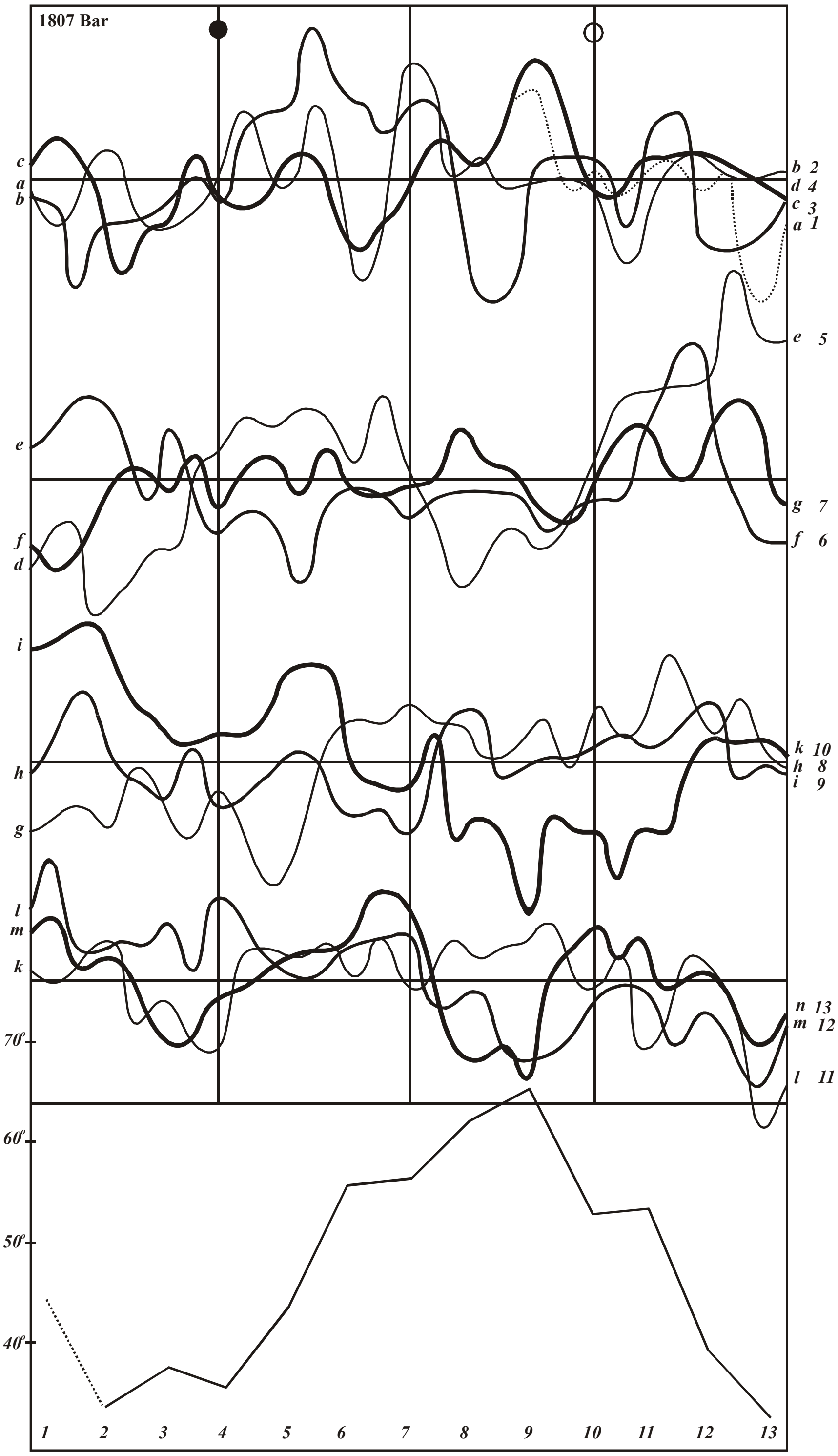
Two degrees of Fahrenheit are equivalent, in these variations, to a tenth of an inch in the Barometer. Such are the proportions observed in this figure, the parts of which are copied from some of the many periods I have traced in this way. When the two curves run in opposition through a period, they cross at intervals, and form a succession of rhombs, differing in magnitude according to the extent of the variation in either or both of the curves: when the two run in conjunction, the resemblance in the number and extent of the changes is often so close, that the one might easily be mistaken for the other. There are also many periods in which both the kinds of relation appear; and some in which neither is very obvious.

In Plate 5, the variations of the **daily mean temperature**, through the Solar year 1806-7 are traced in curves, bearing the proportion already mentioned to those of the Barometer, and constructed in other respects on precisely the same plan as in Plate 4. The corresponding numbers, on the curves in each Plate, will serve to connect those of the Temperature with the Barometrical ones for the same periods.

The place of the **mean line of each period** in the Thermometrical scale, is indicated in the curve at the bottom of the plate.

These curves present features in some respects less striking than those of the Barometrical variation; but which, when attentively examined, indicate equally the existence of a system of variations, governed by the Moon's attraction, as a secondary cause; subject on the whole of the year, to the more powerful influence of the Sun, as he varies in declination.

Plate 5. Exhibiting the variation of the daily mean height of the Thermometer through the Solar year 1806-07.



The greater variations of Temperature, it may be first remarked, appear for the most part during this year in the intervals of the Lunar phases: and there is a tendency in the curves, to approach about the time of the phases to the mean line, commonly in order to cross it, and assume an opposite deviation; from which they often return within the week, as before. The change of the Mean of the period, again, from a lower to a higher place in the scale, or *vice versa*, according to the season, is effected not so much by the gradual elevation or depression of the Temperature through the period, as by sudden bold sweeps of the curve in particular parts of it. Numbers 7 and 8 for the summer, and 10 and 12 for the autumn, approach to the former, or gradual mode of variation; while 5 and 11 may be cited as instances of a more rapid change of level. In each of the latter three periods, the curve assumes a decided tendency upward or downward two or three days before the Full Moon, which it preserves through the following week; the warm or cold weather coming in at once with this movement. Nos. 3 and 5 present almost equally bold upward sweeps, having their **Nodes** (if I may be allowed to use the term) about New Moon; but these elevations do not hold their level afterwards.

If we contemplate the cold periods, Nos. 2, 3, and 4, in connexion, their general character, notwithstanding a large depression in each about the middle, will appear to be that of a rising Temperature by the influence of the **New**, and a falling one by that of **Full** Moon.

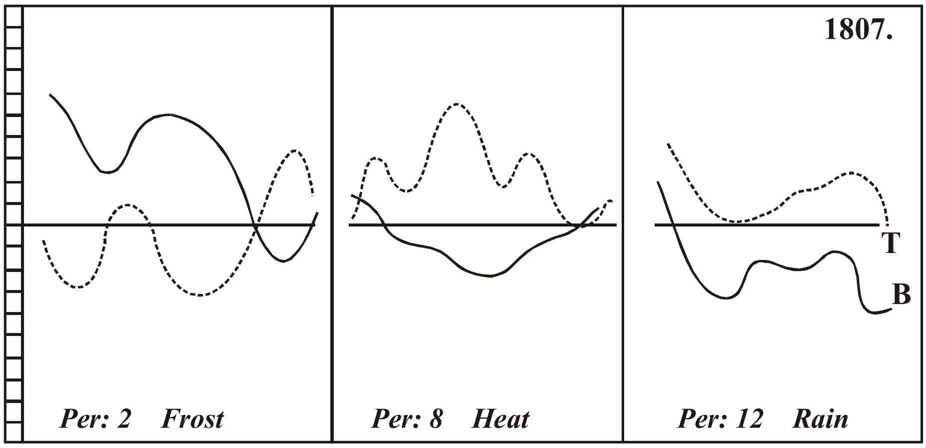
In the periods from No. 5 to 8 of increasing Temperature, the near agreement in the time of beginning their most considerable elevations above the mean will scarcely be thought accidental. Period 5 takes its departure from the mean of 4, and closes very little above that of 6: this period has hence, in effect, five points of intersection with the line; which limit four distinct and contrary oscillations of Temperature, each performed in the space between two Lunar phases.

Lastly, in the three periods of descending Temperature, Nos. 11, 12 and 13, there are six or seven depressions nearly coincident with each other in time. I can scarcely omit to notice here the beautiful manner in which the curve of the mean Temperature (like that of the Barometer) sometimes proceeds in gradually increasing and decreasing oscillations, about a general level or line of direction, which it has assumed for a few days. Period 8 has two examples of this, one below the mean line, the other above it: by the latter the Temperature was carried, on the 22d of the Seventh Month, to the higher extreme of the year: and No. 11 presents a third, in the course of which three weeks of fine weather (which had been attended with an appropriate variation of both instruments) broke up, and gave place to the Autumnal rains.

The Barometrical variation will be found, on comparing together the two systems of curves, to be mostly in opposition to, but at times in conjunction with, the Temperature. In the early cold periods, and in the fine weather of summer, **opposition** will be found predominant; but in the decline of the year, when the atmosphere is losing both heat and water, the two curves often vary in the same direction.

Fig. 22 contains specimens of Barometrical and Thermometrical curves in each state of relation. In the first pair, the season being frosty (the time, the first ten days of 1807) the Barometer ranges high, yet descends a little, to meet an elevation of the Temperature above the mean of the period, in the first week. After this, with a South wind, the two curves suddenly change places, making an intermission of short continuance in the frost.

FIG. 22



In dry hot weather we have the reverse of this arrangement: the Temperature forming oscillations above the mean, and the Barometer an opposite curve below it. Such is the character of the variation for the space of eight days following the 18th of the Seventh Month, chiefly included in period 8, and represented by the Second pair.

The third pair is a specimen of the agreement in direction of the two curves, when the season is tending to Rain. Here we have the Temperature above the mean, but descending; and the Barometer below it, descending also: a slight opposite movement being felt, at the same time by both instruments. This specimen is a part of Period 12, beginning the 1st of the Eleventh Month: and it is by no means the most interesting example which my set of curves, as far as already made out, would present. This week furnished about an inch of water, to the rain-gauge at forty-three feet elevation.

We have next to enquire into the connexion: of these variations with the changes of Wind, and distribution of Rain in each period; which will be found strikingly unequal, and quite as much influenced in this year by the Moon's position as the variation of the Barometer.

I shall first put down the Rain for this Solar year, in a form calculated to show its relation both to the phases and periods. In dividing it, the day of the **phase** was considered as the **middle point** of a **week's** rain; and where any quantity fell on a day equidistant between two phases, it was referred to that with the lowest Barometer.

Period	Last Qr.	New M.	First Qr.	Full M.	Last Qr.
1.	…..	…..	…..	0.04	0.05 in.
2.	…..	…..	0.27	0.21	…..
3.	0.39	0.31	…..	0.24	0.01
4.	0.01	0.25	0.01	0.02	…..
5.	0.37	…..	0.17	…..	0.04
6.	…..	1.57	0.79	…..	…..
7.	0.82	1.22	…..	…..	…..
8.	…..	…..	0.05	…..	0.01
9.	0.25	0.08	1.09	0.01	0.03
10.	0.28	0.05	0.65	…..	0.41
11.	0.41	0.13	0.02	…..	0.52
12.	0.46	0.21	1.42	0.11	0.49
13.	0.64	…..	0.16	…..	…..
Totals	3.63	3.82	4.63	0.63	1.56
					3.63
					5.19
Add one-third for the level, the gauge being at an elevation of 43 feet ….					
		1.27	1.54	0.21	1.73
Rain at the ground		5.09	6.17	0.84	6.92
		Total for the Solar year …..			19.02 in.

The great and almost positive **dryness** of the **Full Moon** week during this year, is thus rendered equally conspicuous with the elevations of the Barometrical curve by which it was accompanied.

The immediate cause of both will presently be shown to be, **the prevalence of Northerly winds during this part of the Lunar revolution**.

A space of eight days being taken out of each period, for the New and Full Moon respectively, with the phase as nearly as could be in the middle of the time, the daily observations on the wind were found to number as follows:

Winds.		New M.		Full M.
N and NE	…….	13	…….	20
N-West	…….	7	…….	21
West	…….	19	…….	15
S-West	…….	33	…….	17
S and SE	…….	6	…….	4
East	…….	5	…….	11
	Totals	83		88

The North-west, which has been already shewn to be our fair weather wind, appears here thrice under the aspect of the Full, for once under that of **New** Moon: and the North and North-east are more frequent in the former, in the proportion of three to two.

On the other hand the New Moon, which exhibits so many depressions of the curve, has about double the number of South-west, and a proportion of three to two of South-east winds, compared with the full.

The West wind predominates here in the division allotted to the New; and the East, to more than double, in that of the Full Moon. I do not consider this disparity as so much connected with wet and dry, as the former between the Northerly and Southerly winds. But so far as it is concerned, the **East** wind appears to have been productive rather of **Rain**; as will appear by the following statement, in which a week's observations are taken out, for each quarter, with the phase in the midst.

Winds.		First Qr.		Third Qr.
N and NE	…….	8	…….	21
N-West	…….	9	…….	6
West	…….	20	…….	10
S-West	…….	26	…….	13
S and SE	…….	2	…….	8
East	…….	0	…….	9
	Totals	65		67

Here the Third quarter, which is the wettest phase, has thrice the amount of Easterly winds that appears in the First: and only half as much South-west. But in a very dry year, it is not so easy to decide from what quarter we receive the rains, as when the cases of heavy rain are multiplied.

On the whole of this year, a connexion between considerable depressions of the Barometer and the more copious rains is sufficiently apparent; although there are large depressions attended with but little rain. For the former, see periods 3, 6, 10, 11, 12, 13, and for the latter, 2, 5. In periods 3, 4, 7 and 9, there are examples of rain connected with a mean height of the Barometer, and a mean Temperature for the season.

The influence of the Moon on the Temperature and density of our local atmosphere appears therefore, with respect to these more obvious and frequent changes, to be exercised chiefly through the medium of the Winds. It is a secondary effect of her varied attraction; which continually tends to change the bearings of the different currents, in motion in the great body of the atmosphere; and we are thus successively involved in all their modifications. Not but that there are seasons, in which the predominant Solar influence is exerted, to a degree which renders these Lunar changes of small consequence: and when, in spite of the various aspects of our attendant planet, we are drenched with rain or parched with drought for months together.*

The variation of 1807, like that of 1798, appears to be in great measure peculiar to the year in which it is found: and it gives place in the succeeding years to a different set of combinations.

The elevations of the **Barometer** about the Full Moon, for instance, which appear in 1807, are found in much less proportion in the next year; and in 1809 they mostly yield to depressions in the same place: the New Moon acquiring in the mean time longer and more numerous elevations.

With regard to **Temperature**, again, the different positions afford different results as the years proceed. In 1807, the average of the mean Temperature taken upon each day through the twelve periods, exhibits a very regular appearance. The Temperature thus obtained being laid down in a curve upon the Mean of the whole, it is found to descend below the mean line, in the intervals between Last Quarter and New Moon and. First Quarter and Full Moon respectively, the depressions being carried a little beyond the latter phases: it then rises more abruptly than it fell, and the elevations thus formed in the alternate intervals go off before the arrival of the Quarters. But in the two following years, the parts occupied by these elevations were found by the same method to be passing off into depressions; and those before occupied by depressions first rising to the mean line, and then becoming elevations.

The mean Temperature of these respective intervals for 1807, taken at equal distances and with a clear day allowed after each phase, were found as follows:

Mean Temp. from	Last Quarter to New Moon	47.04°
	New Moon to First Quarter	49.66°
	First Quarter to Full Moon	47.67°
	Full Moon to Last Quarter	49.78°

The **proportions**, only of the rise and fall would have been somewhat different, had the Temperature been taken strictly from phase to phase. The Temperature of our atmosphere during

* "By what law of Nature is the atmosphere governed? We have not had any rain, generally speaking, since last harvest, (date, Feb. 19, 1777.) Springs have not yet begun to rise, deep wells in general want water, and many ponds are not yet filled: even the surface of the earth is not satisfied." Marshall:. Minutes, &c. on Agriculture in the Southern counties.

The same – "June 23. The spring seed-time was moist, but not remarkably wet: the clouds reserved their bounty for May and June. The middle of May was very wet, and so is the middle of June. The last ten days have been, except one, uniformly rainy. Last night, it poured for eight or nine hours: perhaps never more rain fell in so short a time; the ground was never so wet since the deluge?"

The same – "July 15. From 23rd June to the 8th instant, there was scarcely fair day. The rain set in June 13: it therefore lasted 26 days, with scarcely one fair day intervening. The attendant circumstances were these. The Barometer **hovered about changeable**, and seemed to watch the motions of the wind, which was generally SW. Whenever it veered round to the Northward, the air got heavy; but as soon as it returned to its old station, the Barometer as regularly got back to changeable.

"**The impotence of the Moon was fully proved: she became full, shifted her quarters, and even changed, without the least effect**. The wind alone seemed to rule: for as soon as it was fixed in the North, the rain ceased, and before it had been eight and forty hours there, the weather changed from very cold, for the time of year, to very hot. The change of the wind was preceded by a very heavy squall in the night."

On these facts I would remark as follows. The law by which the atmosphere was on this occasion governed, appears clearly to have been the ordinary law of compensation. A long dry time preceded a long wet one: and the distribution of wet and dry, instead of being comprised within a month, (as is often the case with us,) occupied three whole seasons; the dry extending from the Autumnal Equinox to the Vernal; the wet, from the latter to near the point of highest temperature, a month after the Summer solstice: when the Southerly current suddenly shifted its range, and we were again placed in the dry air returning from the Northward; which, together with a clear atmosphere above, brought on a free radiation and warm weather. "The impotence, of the Moon" during the rains, appears to have been a consequence of the absolute control of the Sun over these currents through the season.

this year was therefore alternately elevated and depressed, to the amount of at least **two degrees** in each Lunar week, by some cause connected with the Moon's positions; which yet did not operate precisely in the same way in the following year. Indeed, the curve of the Lunar mean Temperature for 1809, obtained in the manner before mentioned, is in its general appearance a contrast to that of 1807.

The Full Moon week also loses, in 1808, its **dry** character; which is not immediately taken up by another phase: it exhibits in this year about four inches of rain: and rather more in 1809. The **wet** phase in 1808 is the First Quarter; and it is so again, though with a smaller excess over the other quarters, in 1809; the Last Quarter becomes drier in proportion.

The relative changes in the direction of the prevailing winds in each part of the Lunar period, for these two years, have been as yet but imperfectly examined.

A great depression in the Barometer appears in 1807, in the period No. 2, which goes off with a remarkable upward sweep of the curve, about the time of Full Moon. There are nearly parallel depressions, equally conspicuous, in the two following years. In 1808, the sudden rise after the crisis occurs twenty days earlier in the year, and with a like relation to the First Quarter: in 1809, it is about twenty days later, and attached in like manner to the time of New Moon. It is remarkable that in each case the full pressure was restored chiefly by means of **South-west** winds; and without any excess of rain, or storm of wind. Such periodical large movements, and in the backward order of the phases in this instance deserve notice; as being probably connected with extensive changes in our Northern atmosphere: perhaps with the shifting, through several degrees of Longitude and Latitude, of the range of the larger currents, which depend on the Sun's progress in North or South declination.

Being curious to know whether the difference of the Lunar positions, which occasioned so unequal a distribution of the Rain, had a similar effect on the **Evaporation**, I took out weekly portions from my Tables, with the phase in the midst of the time, as before for the rain; and found that even in 1807 and the latter part of 1806, the amount of Evaporation for twelve periods under the Full Moon was 9.84 in. the same under the Last Quarter being 9.55 inches. And having formed an average, for the three years of which I have more particularly treated, the amounts raised in equal times, under each phase, were found so nearly alike, as to render the conclusion inevitable, **that the Lunar positions, however they may affect the distribution of the Rain, produce no sensible difference in that of the Evaporation**.

This process is nearly a continuous one through the year: it is an effect of the temperature of the water, modified by the greater or less velocity of the wind agitating its surface, and diffusing the vapour produced. But **Rain** is an occasional process; and appears to require a more complex arrangement of causes, at least for its prevalence in a given district. We have, here, to take into account the Temperature and Electricity, absolute and relative, of both the earth and atmosphere; the relative temperature, moisture, and perhaps, electricity of different simultaneous currents, [in the latter;] the direction of these with regard to neighbouring seas and continents, and to the slope or exposure of the district itself; and lastly, as it seems, the Moon's influence.

I have now to give some account of this influence as exercised on our atmosphere, **2ndly, according to the Moon's place in North or South declination**.

The inquiry into this part of the subject was first proposed to me by Silvanus Bevan, junior, of London, lately deceased. What I shall offer upon it is principally derived from his minute and accurate examination of the data furnished by my Register. Other parts of the work had been before improved by his assistance; and the diagrams were nearly all finally prepared by his hand for the engraver. Had his life been prolonged until now, I still should not have been satisfied to conceal the obligations thus contracted to my affectionate friend and zealous coadjutor; in whom a large natural capacity matured by study and practice was joined to great correctness of taste and judgment: and (what is a yet more pleasing reflection) his mental qualities were enhanced by the faith of a Christian, by an unblemished conduct and polished manners. His bodily constitution was however so feeble, that the utmost care over it sufficed not quite to middle age; and at the approach of the late winter, [1819] a pulmonary complaint, before habitual, became exacerbated to a degree which speedily brought on his dissolution.

The object of this enquiry, (which my deceased friend had left imperfect,) may be thus stated. Since it is evident that the Moon exerts an influence, through the medium of the winds if not also directly, on the atmosphere of these Latitudes, the effects ought to be felt in a greater degree when that planet, by acquiring her highest North declination, becomes at her meridian altitude almost vertical to us, than when, being South of the Equator, she is vertical to a distant Latitude in the other hemisphere. To ascertain this, it was necessary to submit some part of the observations, in my First volume, to the like test as in the case of the Lunar phases; by comparing, in detail, particular results with a general average. The years 1807 and 1816, the one the driest, the other the wettest of a series of eighteen years, were selected as first entitled to notice; and the results have proved of greater value than either of us had anticipated. It is evident from these two years alone, that not only the variable pressure of our atmosphere, but its mean temperature likewise, and the periods of the deposition of rain, are modified by the Moon's declination. Thus, another important feature is added to this already complex subject: and the same anomaly, arising from the combinations of different causes producing the phenomena, is found here also — that particular results appear in opposition to a general rule: which rule is yet in the end satisfactorily established by general averages.

[Having paid a just tribute of regard to the memory of the dear friend whom I have mentioned, I shall in this place throw before the Reader some reflections, calculated to allay the chagrin he may have felt, on looking over this Second Edition, at finding this very interesting enquiry prosecuted no further than before. It has not been for the want of labour bestowed, on my part: I have gone through computations which have occupied a considerable portion of my time, in retirement in the country; and I do not repent this application of my time; but to have published the Results in a crude state, and unformed into system, would have been quite another matter. I have now, (I own it with regret, and with some degree of shame for my country,) **neither coadjutor nor encouragement**. Science is become a mercenary scramble — there is no nobility of purpose left in it, or concern for the common good — every one seeks his own, and (what is worse) to bear down another. What may be the cause of all this, except that we have fallen into religious and political differences, I know not; but I am not myself conscious of having given just occasion for shyness to my friends in science. Alas! I have perhaps forgotten that I am now sixty, and that many of the companions of my early studies are gone hence; or are, like myself, sated with the feast; and solicitous only to put their houses in order, and leave an untarnished name. Well! Let posterity make use of the materials we have provided, and build on our foundations. I am not solicitous, for further fame on earth; and I have learned (I thank God!) to despise the senseless imputations cast, by too many, on studies of the nature of those in which I have been engaged. I believe still, that we are worthily occupied, as rational creatures, in tracing the ways of Omnipotence, in investigating the creation, and the laws to which it is subject.-

In the prospect of being enabled, at some time, to publish them, I have taken off, and continue yearly to preserve, the Barometrical curves, traced on the face of the Clock mentioned in my Introduction: the daily **maxima** and **minima** of which are inserted in my Observations. I have likewise cast the **Mean Observations** on the Barometer, Thermometer, and Rain in Lunar periods, on the plan here exemplified. In the progress of these calculations, and in the comparisons into which they have led me, I have seen much to convince me that we are, as yet, only on the confines of a vast field of research in this department of science. Why Meteorology should not be thus explored, and become, as Astronomy has been, through so many ages, the subject of the labour and co-operation, the correspondence and controversies of men of enlarged minds, I am at a loss to conceive. Surely there is nothing presumptuous or profane, (much less weak and crazy,) in a knowledge of the material elements, and their changes; and in the applying this knowledge to our benefit in the affairs of life; as in agriculture, navigation, and the like. Observation and fair induction, and further research grounded on such attainments, form the only method I can recommend to my successors, for the prosecution of these studies; and I shall now dismiss the digression, heartily wishing success, and the enjoyment of the fruit of his own industry, to every honest labourer in my favourite occupation.]

BAROMETRICAL AVERAGES, IN HALF-PERIODS OF LUNAR DECLINATION: FROM 29-30 DEC. 1806 TO 20 DEC. 1807, OR THREE HUNDRED AND FIFTY-FIVE DAYS AND A HALF: MEAN OF THE WHOLE 29.816 INCHES.

Per.	Days	Moon South		Days	Moon North		Days	Mean of both
1	14	30.178	+221	13½	29.732	-225	27½	29.957 in.
2	14	29.676	-089	13	29.860	+095	27	29.765
3	14	29.928	+018	13½	29.892	-018	27½	29.910
4	14	29.907	+105	13½	29.694	-108	27½	29.802
5	13½	29.970	+246	14	29.486	-238	27½	29.724
6	13½	29.927	+044	13½	29.837	-046	27	29.883
7	13½	29.972	+026	14	29.921	-025	27½	29.946
8	13½	29.789	+022	13½	29.744	-023	27	29.767
9	14	29.847	+009	13½	29.866	-010	27½	29.856
10	13½	29.814	+056	14	29.705	-053	27½	29.758
11	13½	30.005	+136	14	29.738	-131	27½	29.869
12	13	29.486	-036	14	29.556	+034	27	29.522
13	13½	29.648	-206	14	30.042	+118	27½	29.854
	Mean	28.957		Mean	29.775		Mean	29.816

NOTE.-The spaces taken are those during which the Moon was successively in N, and S declination: the fourth and seventh columns show the quantities by which the average height of the Barometer for those spaces fell short of, or exceeded the average of the period, as given in the last column.

AVERAGES OF THE BAROMETER AND THERMOMETER IN QUARTER-PERIODS OF LUNAR DECLINATION, FROM THE 3D OF 1ST MO. (JAN.) TO THE 23D IF 12TH MO. (DEC.) 1807, OR THREE HUNDRED AND FIFTY-FIVE DAYS.

Mean Temperature 48.58°.

	Full South Declination				**Mean Declin.** Moon going N.			
Per	Days	Barometer		Therm.	Days	Barometer		Therm.
1	7	30.203	+.389	33.36	7	29.938	+.124	34.69°
2	7	29.434	-.380	33.25	7	29.687	-.127	43.32
3	7	30.161	+.347	35.03	7	29.810	-.004	32.14
4	7	29.691	-.123	37.93	7	29.997	+.183	37.54
5	7	30.016	+.202	54.50	7	29.629	-.185	60.36
6	7	29.943	+.129	60.36	6	29.721	-.093	51.88
7	7	30.024	+.210	58.61	6	29.866	+.052	61.92
8	7	29.844	+.030	66.32	7	29.708	-.106	69.32
9	7	29.792	-.022	65.75	6	29.887	+.073	79.29
10	7	29.759	-.055	54.07	6	29.903	+.089	45.83
11	7	29.786	+.172	58.46	7	30.071	+.257	58.39
12	6	29.510	-.304	44.21	7	29.391	-.423	39.69
13	7	29.808	-.006	32.39	6	29.661	-.153	33.54
	90	29.852	Means	48.57	86	29.789	Means	49.57

N.B. The spaces are as nearly as possible those which have the Moon's greatest N or S declination, or her position on the Equator in their middle. The differences of the Barometer refer in this Table to the general average only, or 29.814 in.

Mean of the Barometer 29.814 in.

Full North Declination				**Mean Declin.** Moon going S.			
Days	Barometer.		Therm.	Days	Barometer.		Therm.
7	29.375	-.439	36.39°	6	30.392	+.422	33.50°
7	29.906	+.092	38.93	6	29.699	-.115	39.83
7	29.789	-.025	34.96	7	30.102	+.292	38.04
7	29.501	-.313	48.82	6	29.704	-.107	38.33
7	29.388	-.426	52.25	7	30.051	+.137	54.36
7	29.822	+.008	57.93	7	29.954	+.140	58.64
7	29.844	+.030	58.25	7	29.945	+.131	61.14
7	29.728	-.086	65.79	7	29.844	+.030	62.86
7	29.806	-.008	57.43	7	29.929	+.115	62.07
7	29.714	-.100	55.04	7	29.740	-.074	53.11
7	29.667	-.147	55.32	7	29.598	-.216	45.57
7	29.743	-.071	37.54	7	29.316	-.498	35.39
7	30.125	+.311	36.04	7	30.202	+.388	32.18
91	29.724	Means	48.66	88	29.881	Means	47.83

In the Table, page 109, the Barometrical observations for 355½ days of 1807 are reduced to averages, on half periods of 13, 13½ or 14 days; during which the Moon was in North or South declination. These are contrasted, in each case, with the Mean of the whole period. In ten out of thirteen cases, the Barometer averaged above the mean, while the Moon was in South declination; and below it, while she was in North declination: **three** exceptions appear, which belong to the **winter**.

The total results are these,

On 177½ days with the Moon South……………	29.857
On 178 days with the Moon North ……………...	29.775
Mean of the 355½ days ………………………..…	29.816 in.
Elevation for her position South of the Equator ...	.041
Depression for her position North ………………	.041

A similar calculation of averages having been made for 356 days, from the 24th of 12th Mo. 1815, to the 13th of the same, 1816, but without descending to half-days in dividing the periods, the results are as follows:

On 180 days, Moon South ……………………….	29.765
On 176 days, Moon North ……………………….	29.704
Mean of the 356 days …………………………….	29.735 in.
Elevation for her position South …………………	.030
Depression for her position North ……………….	.031

The Barometer having stood lower and ranged less in this year than in 1807, the variation for declination is less in amount accordingly. The cases which appear against the general rule, or in which the Barometer averages **higher** under a **North** declination, form in this year a majority, occurring in seven out of thirteen periods; and of these seven, **five** clearly belong to the **summer** half-year.

In the Table, page 110, the mean Temperature is taken along with the mean heights of the Barometer for 1807, and each period is divided into **quarters**. The intention of this was, to ascertain separately the respective effects of a full South, of a full North, and of each kind of mean declination. In making up the results, the **Rain** for each of these quarters, ascertained by a separate calculation, and corrected for the elevation of the gauge, is likewise inserted. The results are,

1. For the quarter-period in which the Moon was in Full South declination:
   Barometer ………………………………………. 29.852
   being above the general mean ……………… .038 in.
   Thermometer …………………..… 48.57°
   being below the general mean …. .01°.
   Rain 3.56 inches.

2. For the quarter-period in which the Moon was coming North across the Equator:
   Barometer ………………………………………. 29.789
   being below the general mean ……………… .025 in.
   Thermometer …………………..… 49.57°
   being above the general mean …. 1.00°.
   Rain 4.96 inches.

3. For the quarter-period in which the Moon was in Full North declination:
   Barometer ………………………………………. 29.724
   being below the general mean ……………… .090 in.
   Thermometer …………………..… 48.66°
   being above the general mean …. .08°.
   Rain 6.67 inches.

4. For the quarter-period in which the Moon was going South across the Equator:
   Barometer ………………………………………. 29.881
   Thermometer …………………..… 48.53°
   being below the general mean …. 1.05°.
   Rain 3.72 inches.

Having constructed a similar Table for a space of 355 days, beginning the 28th of the 12th Mo. 1815, and ending the 17th of the same, 1816, I found the results as follows; the general mean of the Barometer being 29.723 inches; of the Thermometer 47.09°; the Rain taken at the level of the ground.

1st Quarter-period, Barometer …………………………		29.797
above the general mean ………………………………		.074 in.
Thermometer …………………..…	46.14°	
below the general mean …………	0.95°.	
Rain 6.65 inches.		

2d Quarter-period, Barometer …………………………		29.793
above the general mean ………………………………		.070 in.
Thermometer …………………..…	48.73°	
above the general mean ………...	1.64°.	
Rain 8.21 inches.		

3d Quarter-period, Barometer …………………………		29.559
below the general mean ………………………………		.164 in.
Thermometer …………………..….	47.00°	
below the general mean …………	0.09°.	
Rain 9.99 inches.		

4th Quarter-period, Barometer …………………………		29.678
below the general mean ………………………………		.055 in.
Thermometer …………………..…	46.51°	
below the general mean ………...	0.58°.	
Rain 5.49 inches.		

Summary of the effects in these two years.			
1. With the Moon full South			
		1807	1816
Barometer		above the mean falling	above mean rising
Temperature		about mean	at lowest average
Rain		the minimum quantity	near the minimum quantity
2. With the Moon coming North			
Barometer		below mean	at highest average
Temperature		at the highest average	at highest average
Rain		much increased	much increased
3. With the Moon full North			
Barometer		at lowest average	at lowest average
Temperature		about mean falling	about mean
Rain		the maximum quantity	the maximum quantity
4. With the Moon going South			
Barometer		at highest average	below mean rising
Temperature		at lowest average	below mean
Rain		nearly at the minimum	the minimum quantity

The most considerable and striking effect of the Moon's positions in declination here exhibited, is certainly that of the unequal distribution of the **Rain**: which I shall therefore first notice.

It appears that, while the Moon is far South of the Equator, there falls but a moderate quantity of rain with us; that while she is crossing the Equator towards these latitudes, our rain increases; that the greatest depth of rain falls, with us, in the week in which she is in Full North declination, or most nearly vertical to these latitudes; and that during her return over the Equator to the South, the rain is reduced to its minimum quantity. **And this distribution obtains in very nearly the same proportions both in an extremely dry, and in an extremely wet season**.

The next point to be attended to is the Temperature in which the two years exhibit (in this respect) some striking coincidences.

In both years, the Temperature is at its highest average (for the period,) while the Moon is coming North over the Equator. During her continuance in North declination, the temperature in both passes the mean of the period, descending. In the **dry** year, it attains its lowest average while she is proceeding South again: but in the **wet** year, this takes place in the following week, or while she is in full South declination.

I have already exhibited for the year 1807, an unequal distribution of rain, as well as a periodical variation of Temperature, connected with the Moon's **phases**. It will be proper for the reader's satisfaction to recur to these, and to show that both in 1807 and 1816, the effects which I have attributed to the Moon's position in declination, are distinct from those before shown to arise from her change of place in revolution.

The Moon was in her Third or Last quarter on the morning of the first day of 1807; she returned to the same phase, after having made twelve revolutions in her orbit, early in the morning of the 22d of the Twelfth month of that year.

There was a New Moon on the afternoon of the 30th of 12th Mo. 1815; and again, after twelve revolutions, on the 18th of the same month, 1816.

The reader will find, on comparing these intervals of time with those taken for the declination, that **thirteen** periods of the latter nearly correspond with twelve revolutions; consequently the Moon must have presented every variety of phase, during these spaces, in conjunction with any given degree of North or South declination; and every variety of the latter together with any given phase: a state of things which effectually precludes us from ascribing to the one, any variation presented, **upon the whole of a nearly coincident space of time**, by the other.

The diminution of the average rain for the weeks of Full South declination, was therefore, in 1807, independent of the dryness before attributed to the influence of the Full Moon in that year; which was a still more striking phenomenon. Let us see how the case stood, in this respect, in 1816.

Having divided the rain for this year also, according to the phases **about**, and **between** which it fell, and likewise computed the mean Temperature for each of the spaces (which are here denominated weeks) the results are as follows:

In 1816,		Rain (in.)	Temp.
	For the week **about** New Moon,	6.11	47.10°
	For the week **about** First Quarter,	10.10	46.60°
	For the week **about** Full Moon,	9.13	47.17°
	For the week **about** Last Quarter	5.51	48.39°
		Total 30.85	Mean 47.31°
	For the week **after** New Moon,	5.21	46.85°
	For the week **after** First Quarter,	12.49	46.88°
	For the week **after** Full Moon,	7.41	47.78°
	For the week **after** Last Quarter	4.20	47.75°
		Total 29.31 in.	Mean 47.31°

The Full Moon week in 1816, instead of being distinguished for dryness, as in 1807, was excessively wet: the greatest depth of rain, however, fell in the space intervening between First quarter and Full Moon; and the **driest** part of the space included in each Lunar revolution was **in the opposite part of the orbit**, between Last quarter and New Moon. The reader has only to turn over the Tables, from CXIV to CXXVI inclusive, in the Second volume, to be convinced of the fact in each instance. With the exception of the week following the summer solstice, in which there fell heavy rain before and after New Moon, the weight of the rain, this year, lies, in a very remarkable manner, within and about the third week of each period, or the space above mentioned; until we come to the latter part of the Eleventh Month and beginning of the Twelfth; when this space suddenly becomes **dry**, and that following the next Last Quarter becomes **wet**. It is observable, though I do not pretend to establish a connexion between the phenomena, that a Solar and a Lunar Eclipse are included in this period, which is so conspicuously dry in this very wet year: the rain being only half the average quantity of the season.

I have remarked that the Lunar orbit, in 1816, appears to have had **a wet and a dry side**, as regards the Moon's influence on the rain of our climate. It appears likewise from the preceding statement, that the Mean Temperature, taken about the phases, was highest for the Last quarter, and lowest for the opposite part of the orbit or First quarter; passing through a mean state for the intermediate phases of New and Full Moon. Thus the **cold** aspect of our attendant planet was, in this year, also the **wet** one: and the same arrangement that brought more warmth, brought also comparative dryness. And this, (as in the very dry year of 1807), subject to a distinct and independent effect, produced by the Moon's declination; to the consideration of which we may now return.

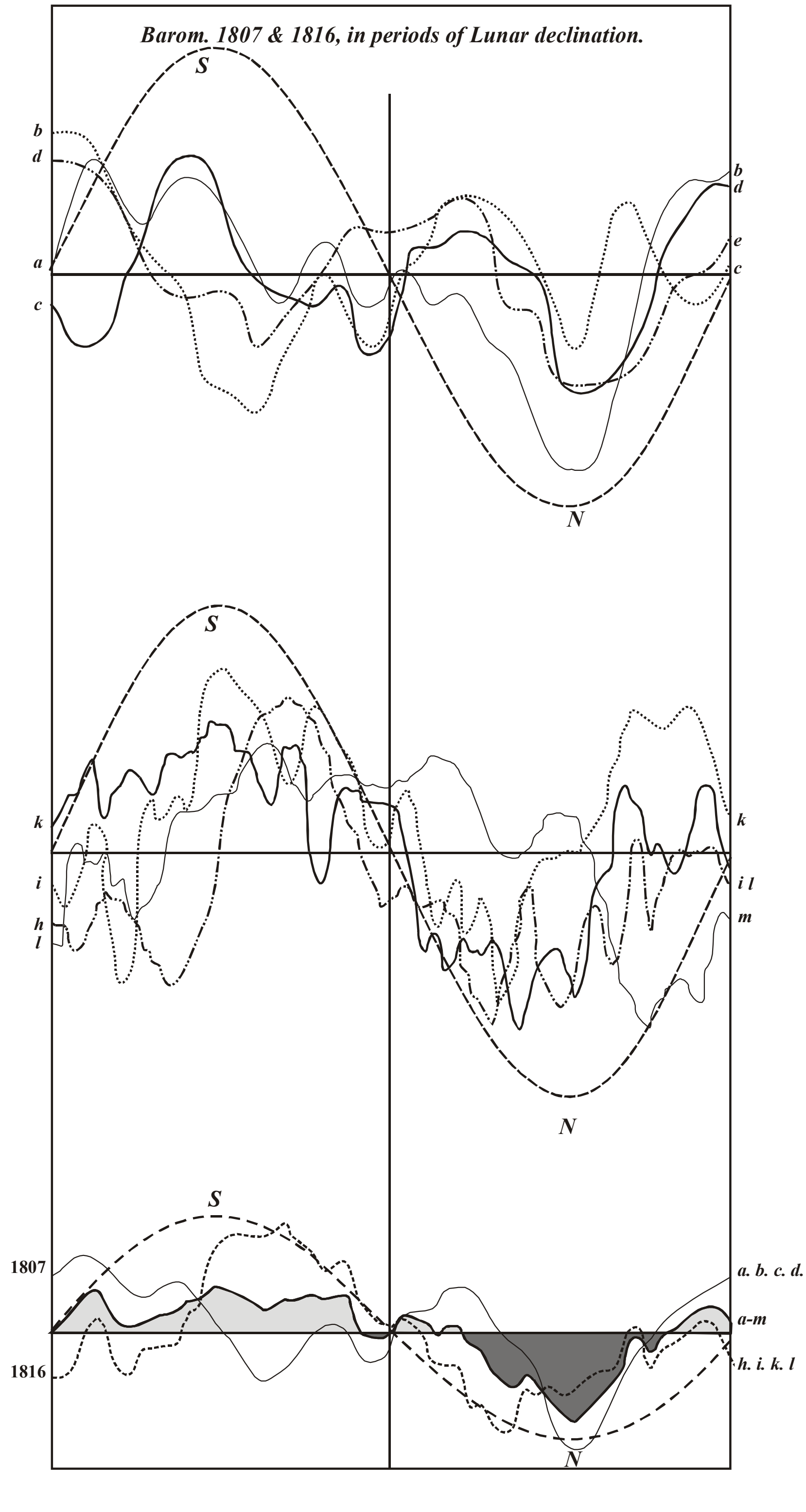
In order to place in a more striking light the effect of the Moon's **declination** on the Barometer, as well as to show the agreements and differences in this respect, of a very dry and a very wet year, I have given, in Plate 6, four periods of 1807, and as many of 1816, taken in each case from the winter and Spring; in which seasons these effects are the most conspicuous. These curves represent the movements of the Barometer from the day of the Moon's crossing the Equator, going South, to that of her return in the same direction to the same position. The regular curve, which accompanies them in each figure, represents the Moon's course in declination; the horizontal line being the Equator. In the **upper** figure, the curves are constructed from the **medium** height of the Barometer for each day; each of them having its mean point in the horizontal line. Consequently the Reader, knowing the mean of the period, with the time of its beginning, and availing himself of the help of an Ephemeris, for the successive times of the extreme South and North declination, &c. may verify for himself, by the Tables from II to VI inclusive, (Vol. II) the accuracy of these delineations; the regular appearance of which, in some parts, may seem not unreasonably to require proof by measurement. Yet they are the result of observations made without the remotest conception of their being ever applied to this standard, and in a manner which I cannot but consider, now, as imperfect.

The **lower**, or second set of curves, give the variations of the Barometer at their full extent, as recorded on the face of the Clock, of which I have already given an account in the **Introduction**: and in consequence of their showing all the smaller variations, which are sunk and lost in the curves constructed from medium heights, their general appearance is very different from the former.

These curves will be found to agree nearly, but not exactly, with the observations in the Tables from CXIV to CXVII inclusive: the latter having been obtained, not from the Clock, but from a Barometer in the ordinary way.

In the third or **lowest** figure, the four sets for each year are respectively reduced to a mean curve, which is adapted to a common mean line: and a medium curve, passing between these two, exhibits, finally, the total or average effect of the declination on the Barometer, for the whole of the space taken for this examination.

Plate 6. Illustrative of the effect of the Moon's declination on the Barometer.



Time of beginning, and mean height of the Barometer, (represented by the horizontal line,) for each of the curves in Plate 6.

For 1807					
Curve **a-b**	begins	30-31	of 12 Mo. 1806;	mean line at	29.97 in.
b-c	…….	29-27	Of 1 Mo. 1807;	………..	29.76 in.
c-d	…….	23	Of 2 Mo. 1807;	………..	29.92 in.
d-e	…….	23	Of 3 Mo. 1807;	………..	29.79 in.
For 1816					
Curve **h-i**	…….	23-24	of 12 Mo. 1815;	………..	29.64 in.
i-k	…….	19-20	Of 1 Mo. 1816;	………..	29.66 in.
k-l	…….	16	Of 2 Mo. 1816;	………..	29.64 in.
l-m	…….	15	Of 3 Mo. 1816;	………..	29.79 in.
For the whole					
Curve **a,b,c,d**, Mean of 4 periods of declination, beginning 30 of 12 Mo. 1806, ending 19 of 4 Mo. 1807,				………..	29.86in.
Curve **h,i,k,l**, Mean of 4 periods of declination, beginning 23 of 12 Mo. 1815, ending 11 of 4 Mo. 1816,				………..	29.68 in.
Curve **a-m**. Mean of the above 8 periods,				………..	29.77 in.

It will be convenient to begin the examination of these curves with the last, or general one, which, it will be recollected, gives the daily mean heights of the Barometer through a period of declination, upon averages of eight days each; the observations taken in Seasons remote from each other, and under all the variety of weather to which the winter and spring months are incident: consequently, in a manner calculated to secure the fairest results.

The general appearance of the curve **a-m** confirms the position already deduced from calculations on a larger space. It is, for the most part, above the general mean during the Moon's continuance in South declination, and below it during the North declination. The depression for the latter is, moreover, the most regular part of the whole variation; its crisis coinciding very nearly with the time of the Moon's beginning to return South: and the times of its departing from and returning to the Mean being symmetrical. In this part also, the respective curves of the dry and the wet year present appearances the most nearly alike; and it is observable, that in the dry one the curve descends lowest.

The curve also runs highest in the wet year, on the South side of the period; where we find the greatest difference, and indeed opposition, to prevail. While the Moon proceeds towards the South from the Equator, the Barometer of the dry year, which had risen at the going off of the Northerly depression, falls; and that of the wet year, which had continued, as it were, struggling below the mean, rises. Two or three days after the Moon has begun to come back from the South, each of the curves again changes its direction; that of the wet year now enters on a fall of ten days, which carries it across the mean to its lowest point for the whole period: that of the dry year rises for nearly an equal space, attaining a moderate elevation above the mean; from which it passes into the Northerly depression. Thus the wet year has the Barometer at a high level for a week only, while the Moon is approaching the Equator from the South, and the remainder of the period may be said to be nearly occupied by depressions: and the dry year is subject to a considerable depression, during the week of Full North declination; the rest of the period being chiefly occupied by a mean or elevated Barometer. And supposing a rule to be found, for the periodical return of such extreme wet and dry years, we have here (so far as regards the winter months,) a pretty certain method of anticipating the time of the occurrence of storms, in the fair season, and of fair and moderate intervals, in the wet and stormy one. Such are the mean movements of the Barometer, in these two seasons so opposite in their character, for the winter and early part of spring. It was not found expedient to introduce a greater number of curves into the figures, or to attempt, in this place, the solution of more complicated appearances. We may now, therefore, advert to these curves singly, or as groups, in order to inquire into the attendant winds, and other circumstances.

The elevations belonging to the week in which the Moon was crossing the Equator, southward, in 1807, constituting the extreme parts of the four curves, were accompanied by winds from the **South-west**, **West**, and **North-west**. There appears but one observation of NE, and two of E, in this interval; and not one of a South wind.

The movements, in 1816, for this space, in which depressions predominate, had winds from the **South-east**, **South-west**, and **West**. Three or four cases only of a Northerly wind appear, along with the great elevation in curve **i-k**, continued in **k-l**. This was at the going off of the severe frost of that season, in which the Thermometer stood a whole night at 5 below the zero. The crisis of the Barometrical depression, on this occasion, fell on the morning of the 7th of Second month, which is the date of the lowest point of the curve **i-k**; and the same winds which brought that intense cold, produced also the great rise of the Barometer.

For the week of Full South declination we have, in 1807, for the most part **North**, **North-east**, and **West** winds; the depression at this time in the curve **b-c** was effected by South, South-west, and West winds. In 1816, we have for this space an alternate play of winds; the **South**, **South-west**, and **North-east** predominating in **h-i** and **k-l**, and the **North**, **North-east**, **East**, and **South-east** in **i-k** and **l-m**, with appropriate movements in the curves. The curve **i-k** exhibits a fine upward sweep of five days under NE and N winds, after being three days depressed by the South-east: the crisis of these two movements will be found in Table CXV, at the 24-25 of First Month. Table CXIV will also furnish interesting particulars of the curious sudden depression, immediately preceding the great rise which distinguishes this portion of the curve **h-i**.

We come next to the week of mean declination, the Moon going Northward, in which the two movements again cross each other. The winds here are, in 1807, the **South-west**, **West**, **North**, **North-east**, and **North-west**, without any South or South-east; and in 1816, the **South-west**, **South**, **West**, **North-west**, and **South-east**; without any North or North-east, till we come towards the close of the series. Hence the curve **l-m** presents an exception; being kept up for five or six days, where the others fall, by North-east and East winds, and at length falling (out of course and, where the others rise) by the progress of the wind to South-east and so round to the Westward. This exception, which followed the Vernal Equinox (see Tab. CXVII) extended also to the weather, there being hereabouts seventeen days in succession free from rain, the longest **dry** space in this year!

If we now turn back to the curves for 1807, we shall find in **a-b** a parallel exception. This curve, in crossing the mean line, **descends** on the whole, from the 11th to the 16th of the First month, with a fine movement of decreasing undulation, and with the winds as follow:- W, SW, NW, W, SW, NW. It then enters upon the regular depression for North declination: for the particulars attending this and the preceding movement, the reader may consult Table III. It is probable these movements will be found, hereafter, to be necessary compensations in an extensive system of variations.

There remain now to be considered only the depressions in the week of Full North declination. In 1807 these are very regular, and their crisis agrees nearly with the Moon's being furthest North: in 1816, on the contrary, we see them accelerated or retarded; so that the crisis, (where it can be defined,) lies considerably on one side or the other of this point. The difference would have been still more perceptible, had the curves of 1816 been formed like the other, from **medium** observations.

These depressions are not necessarily attended with gales of wind or heavy rain, at the place of observation. The crisis of that in the curve **b-c** was, however, connected in our district with a very severe gale from the NE, with snow and electrical discharges from the clouds; as that of the curve **a-b** probably was, with a storm at a considerable distance, in Devonshire, which appears by the accounts in the papers to have done much damage. See the dates, First Month 21, Second Month 17, Third Month 17, and Fourth Month 13, in the Tables from III. to VI. inclusive.

In 1816, however, the desultory movements of the Barometer in the lower part of the scale, in this space, did not in many instances baulk the observer's expectation; and there occur in the Tables from CXIV to CXVII inclusive, all the varieties of foul weather, in connexion with them; the particulars of which it is not needful here to point out.

With regard to the **direction** of the winds in this space; in the four periods of 1807, the South-west predominates, and next to it are the North-east and North-west; the South-east again absent: but in 1816, the winds are a perfect mixture, there being no point without at least two observations, and the South-west alone considerably exceeding in number.

The fairest mode of comparing the winds for these spaces is, however, upon the whole year. I have accordingly taken out the observations of these two years, in spaces answering to those of the Table of Quarter-periods of declination for 1807, p.110; and those of a similar Table formed for 1816, the results of which are given with the former.

PROPORTIONS OF THE DIFFERENT CLASSES OF WINDS, IN QUARTER-PERIODS OF LUNAR DECLINATION, FROM THE 3D OF THE 1 ST MO. (JAN.) TO THE 23D. OF THE 12 TH MO. (DEC.) 1807; BEING THREE HUNDRED AND FIFTY-FIVE DAYS, OR THIRTEEN PERIODS OF DECLINATION.

Full South Declination.							*Mean Declin.* Moon going N.					
Per.	Days	N-E	E-S	S-W	W-N	Var.	Days	N-E	E-S	S-W	W-N	Var.
1	7	2		1	4		7		1	2	4	
2	7	1		2	4		7			4	3	
3	7	5			1	1	7	5			2	
4	7	6				1	7	2		4		1
5	7		2	3	1	1	7	1	4			2
6	7	3	2	1		1	6	1	2	1	2	
7	7				7		6	1			3	2
8	7			4	3		7			4	1	2
9	7	1	2		4		6		5		1	
10	7			1	6		6	4			2	
11	7			3	4		7			5	1	1
12	6	1		3	1	1	7		1	3	3	
13	7	2		1	3	1	6	1		1	4	
	90	21	6	19	38	6	86	15	13	24	26	8

N.B. The spaces taken are, as nearly as possible, those which have the Moon's greatest N or S declination, or her position on the Equator in their middle. The winds are taken from the Tables in Vol. I.

Full North Declination.						*Mean Declin.* Moon going S.					
Days	N-E	E-S	S-W	W-N	Var.	Days	N-E	E-S	S-W	W-N	Var.
7	1	1	2	2	1	6			2	4	
7	1		3		3	6			2	4	
7	3		1	3		7	2	2	1	1	1
7	1		4		2	6	4	1			1
7			4		3	7	1		6		1
7			2	2	3	7			4	2	1
7	2	1	1	2	1	7	2	1	2	1	1
7			6		1	7	1		3	2	1
7		1	3	3		7			1	6	
7	1		4	1	1	7		1	3	2	1
7	1		1	3	2	7	1	3	2	1	
7	3			1	3	7		1	4	2	
7				6	2	7		3	1	2	1
91	13	3	31	22	22	88	11	12	30	27	8

PROPORTIONS OF THE DIFFERENT CLASSES OF WINDS, IN QUARTER-PERIODS OF LUNAR DECLINATION, FROM THE 28TH OF THE 12TH MO. (DEC.) 1815, TO THE 16TH OF THE SAME, 1816; BEING THREE HUNDRED AND FIFTY-FIVE DAYS, OR THIRTEEN PERIODS OF DECLINATION.

Full North Declination.							*Mean Declin.* Moon going N.					
Per.	Days	N-E	E-S	S-W	W-N	Var.	Days	N-E	E-S	S-W	W-N	Var.
1	7			5	2		7			4	3	
2	7	5	2				7		2	5		
3	7	1		4	2		7			4	3	
4	7	4	1		2		7	2	5			
5	7	1	2	1	3		7	3	4			
6	7	2	1	1	3		7	4	1	2		
7	7	3	1	2	1		7	3		2	2	
8	7			4	2	1	7		1	3	1	2
9	7			5	1	1	7		2	3	2	
10	6		2	1	3		7			4	3	
11	7	1		4	1	1	7		4	1	1	1
12	7		5	1		1	7	1	2	3		1
13	6	1	3	1	1		7	3		2	2	
	89	18	17	29	21	4	91	16	21	33	17	4

N.B. The spaces taken are, as nearly as possible, those which have the Moon's greatest N. or S. declination, or her position on the Equator their middle. The Winds are taken from the Tables in Vol. II.

Full North Declination.						*Mean Declin.* Moon going S.					
Days	N-E	E-S	S-W	W-N	Var.	Days	N-E	E-S	S-W	W-N	Var.
6		1	3	2		7		3	3	1	
7	4	1	1		1	6	1		3	2	
7	2		4	1		7			4	3	
7	1	3	1	1	1	6	3	1		2	
7		2	1	4		6			4	2	
7	2	2	1	2		7			1	5	1
6	2		1	2	1	7			1	2	4
6			4	1	1	7	1			5	1
7	2			4	1	7	3	2		2	
7	2	1	4			7	3	3	1		
7	1		2	2	2	7			3	4	
7		3	3	1		7			2	3	2
87	17	15	26	21	8	88	11	10	22	35	10

Summary of the distribution of the Winds according to the Moon's declination in 1807 and 1816.

		N-E	E-S	S-W	W-N	Var.	Days
1. With the Moon full South.							
	1807	21	6	19	38	6	90
	1816	18	17	29	21	4	89
2. With the Moon coming North							
	1807	15	13	24	26	8	86
	1816	16	21	33	17	4	91
3. With the Moon full North							
	1807	13	3	31	22	22	91
	1816	17	15	26	21	8	87
4. With the Moon going South							
	1807	11	12	30	27	8	88
	1816	11	10	22	35	10	88
Totals {	1807	60	34	104	113	44	355
	1816	62	63	110	94	26	355

The two classes N-E and S-W are of nearly the same **total amount** in the wet, as in the dry year. The character of a whole year, in this respect, does not appear to be decided by either of them; but rather by the class E-S, which has nearly twice the amount in the wet year, that it exhibits in the dry: and this excess is taken out of the class W-N, and out of the **variable**. In regarding the year as a whole, it is also proper to remark, that a much greater quantity of air undoubtedly passed over us, in all directions, in 1816 than in 1807. The large amount of variable winds, which appear under the Full North declination for 1807, is clearly raised at the expense of the E-S and N-E classes I am not conscious of having used less care respecting these classes in 1816; and am inclined to believe that, during the fine season of 1807, there prevailed a much larger proportion of variable **Easterly breezes**, than of **winds** from either of these quarters. It seems to be one of the conditions of such a season, that the air of the district shall not hastily travel out of it, nor that of a distant one suddenly invade it. **A windy season can hardly fail, in some part of it, to be a wet one**.

The distribution, as well as the amount, of the N-E is nearly alike in the two years. I shall therefore leave it for the present, to attend to the next in order.

The class E-S, which I have already characterized as the principal **importer** of our rains in Spring and Summer, appears to make its way into this district chiefly while the Moon is approaching from the South. The air being thus vapourized to the degree required for the moderate rains of the season, this wind falls off in the dry year, during the week of North declination, to a very inconsiderable quantity: but in the wet year it is reduced to its minimum, only during the return of the Moon to the South.

The class S-W follows nearly the same rule. It increases as the Moon comes North, and decreases as she proceeds South again: but it is more fully manifested, under Northerly declination, in the dry, than in the wet year; continuing nearly undiminished until the Moon is Full South.

Northerly winds are of course more frequent in those seasons when the Southerly fall off. They were at their height in 1807 in both classes, under Full South declination: the W-N in this year, came to their minimum under North declination, the N-E not until the following week, when they were only at about half their greatest amount. In 1816, the class W-N appears to have supplied the place of the N-E while the Moon was going South: falling to half the number in the week of her return Northward, and exhibiting a mean amount in the intermediate weeks.

This account of the Winds, compared with the summary of the effects on the Barometer, Temperature, and Rain, in page 111, may supply us with a key to many of the facts there stated.

A general tendency in the Northern atmosphere to come over us, while the Moon is far South, may he admitted as a cause why the Barometer at this time is above the mean, the Temperature about or below it, and the Rains in small quantity.

As the Moon comes North again, the air returning from the South causes increased temperature: it brings also a great increase of vapour; and the heat evolved during the condensation of this, may possibly be the means of the greater elevation of the mean Temperature at this time, in the wet than in the dry year. Something must however be attributed, in this case, to the actual translation of more of the Tropical air into these latitudes, in a wet season. The increase of the rain at this time, in both seasons, is a necessary consequence of the other arrangements.

Why the Barometer should now be below the mean in the dry, and at its highest average in the wet season, is not equally apparent: but we may further notice its movements in the conclusion.

Under Full North declination, we have the results of the previous introduction of vapour by Southerly winds. In the dry year, the vapour is decomposed in a short space of time, and the attendant gales of wind are single and decided: in the wet, a longer continuance, or a greater number of repetitions of this process, together with the larger product of rain, indicate the operation of numerous currents from distant regions. In each season, these causes suffice to bring the Barometer to its lowest average, and the Temperature to the mean.

While the Moon is returning to the South, the winds from West to North predominating, in the wet year, tend to raise the Barometer and reduce the Temperature. The latter effect may also be now accelerated by Evaporation, as the rains decrease again. It is remarkable that, in 1807, the Barometer shows the highest average for this week, and the Temperature the lowest, with the smallest proportion of N-E, and nearly the largest of S-W winds.

The course of the varying density of the atmosphere in its relation to the Moon's declination, is pretty fairly represented as to direction, though not as to extent, for the whole of the two years, by the specimen given in the two mean curves, **a, b, c, d,** and **h, i, k, l,** in plate 6. It will be important, hereafter, to ascertain fully the principles of these two modes of variation; as they appear, more than any other circumstance (the disproportion of the South-east winds excepted) to mark the difference between a wet and a dry season; and their periodical causes being once known, the return of such seasons may be predicted with some degree of certainty. I consider the scheme which I have given early in this enquiry (page 3) of the varying **mean Temperature** of the years, as calculated in great measure to answer this purpose; it being very clear, that the greatest depth of rain fell in the coldest years, and that the warm years were dry or mean ones. But it will be a great addition to this information, should we be able to prove, from observations now extant, that the Barometer also varies its mean height periodically, **from year to year**; and that both variations are governed by a periodical succession of the different classes of winds.

I might add to the mass of evidence on this subject some proofs of a peculiar relation between the Moon's **Apogee** and **Perigee**, and the mean height of the Barometer on the days on which they occur: but I have nothing as yet so far digested as to be relied on. Indeed the labour of preparing what has now been thrown before the reader, has greatly exceeded my expectations; and being prosecuted with considerable disadvantage, in the midst of other engagements, has delayed rather unreasonably the completion of this part of the work. In publishing, in their present state, so large a proportion of the facts derivable from my observations, I shall undoubtedly throw the whole remainder of them open to the use of others, and may probably be thus anticipated in some important deductions yet to come. But I am not at all jealous of the little merit which attaches to discovery, in a field so rich, and hitherto so little trodden; and shall be well satisfied should others, to whose minds the requisite knowledge of Astronomical relations may be familiar, and their capacity for such enquiries, from a mathematical education, greatly superior to mine, be willing, after examining these data, and correcting such errors as they may find, to take up the subject, and improve upon my beginnings.

If the Moon's attraction be really the principal cause of those variations in the atmosphere which cannot be traced to the influence of the superior planet, the mode of operation of this attraction may be very simple; at the same time that, considering the complicated nature of the Lunar orbit, and the perpetual interference of the Sun's varying power, its manifestations in any given temperate climate may prove a very difficult subject to investigate.

On a train of effects, the most part of which are out of the reach of direct observation, we may be permitted, in this part of the work, to hazard a few conjectures.

The surface of the atmosphere is, I think, less elevated, and better defined, than many persons would be led to imagine it. A portion of air, rarefied by means of the air-pump, does indeed exhibit an elasticity, which seems limited only by the imperfection of the instrument. For the most minute residuum still appears to fill the vessel, and to press against it in all directions. But it does this at a **temperature** which, compared with that of the extreme boundaries of the atmosphere, is probably as that of the steam in a high-pressure engine to the water in a well. We know that, in ascending in the atmosphere, the temperature is found to decrease with the decreasing density of the air: and even under a vertical sun between the Tropics, a line of perpetual snow on the mountains, indicates a boundary within our reach, which the heat never has ascended **in mass** to penetrate. There is consequently no source from whence air, conveyed to the summit of the atmosphere, could take the heat necessary to such extreme rarefaction: the whole sensible heat of the atmosphere being derived originally from the earth's surface, and distributed in an inverse proportion to the elevation. At an elevation, therefore, not perhaps on a mean more than ten times that of the highest mountains, or fifty miles at the Equator, and considerably less at the poles, I conceive there exists a perpetual **zero** of temperature; and with it an effectual limit to the further expansion of the atmosphere. Here, the spheroidal body of gases, enveloping our globe, has probably a well defined surface (its extent considered) where the air, though greatly attenuated, is much less rare than we can make it in the receiver of the air-pump; in a word, a fluid, with a surface capable of rising and falling, like the waters, by change of gravity.

With such a surface, it is plainly possible that the atmospheric ocean may be acted on in the manner of a tide. It may be elevated and rarefied on the side directly opposed to the Moon, and at the same time on the opposite side of the globe; and left to its proper gravity in the remaining part of the mass. And it ought, on this supposition, to exhibit a more perfect example of a tide than even the waters; there being here no shores, as in the ocean, to retard the arrival of the swell at a given place, at the destined hour; or prevent its passing regularly round the middle regions of the globe, in the space of a revolution of the latter on its axis. If I place my hand upon a spiral spring of wire, and depress it, the force being withdrawn the spring follows, and returns immediately to its former state. But if I do the same with a pillow of dawn, this elastic body, consisting of many small parts acting feebly on each other, takes a long time to resume its full dimensions. There is a similar difference in constitution between the ocean and the atmosphere: and it is very probable, that an interval of six hours is not nearly sufficient for the full effect of rarefaction, [the low temperature aloft considered,] and still less for the subsidence and condensation of the air, through its whole depth, to the degree required by the theory of such a tide. The **daily** alternate movements, then, of an atmospheric tide, perhaps from their not having been sufficiently sought among the continual fluctuations of the density of the air at the earth's surface, are not yet demonstrated: but both the Barometer and Thermometer supply, in their respective mean variations, most palpable instances of the weekly increase and decrease of those movements.

In a portion of the atmosphere, the most considerable in point of bulk, situated above the reach of the daily variations of temperature caused by the sun, the alternate rarefaction and condensation here supposed may take place, without producing any other consequence than a current from East to West, around the globe, in that region.

In a lower portion, visited at different times by different proportions of the heat and vapour generated at the earth's surface, it may effect an alternate absorption and condensation of water, with correspondent changes in the Electrical state of this region; and thus contribute to decide the occurrence of strong winds, rain, thunder, and other occasional meteors, below.

Still lower, in a region to which our observation more or less extends, the complexity of the causes must necessarily produce effects more difficult to appreciate; and these are brought about, as it seems, chiefly by the succession and interchange of lateral currents. The rarefaction produced in this region, by the Sun's heat, is admitted to give rise to a most regular and extensive system of these, commonly called the **Trade-winds**. The air around the globe over the Equatorial regions, expanded by the heat rises, or is pushed forward by the contiguous cooler air from the North and South; the motion of which combined with the larger motion of the earth's surface from East to West, as the latitude becomes higher, gives rise to a South-east wind on the South side, and a North-east on the North. Such is the admitted principle of the Trade-winds; and it is thought (indeed it must follow) that the air, thus elevated above the Equator, returns in some kind of currents, above the Trade-winds towards either pole. If we admit a constant Easterly **tide** in the higher tropical atmosphere, into which this rarified air constantly rises, we shall have a powerful auxiliary to the Sun, in keeping up the Trade-winds; and if we admit that the Moon, by her alternate passage to the North and South in declination, sets this tide alternately to the Northward and Southward of the line, we shall have a principle on which to solve the greater abundance of rain, and the brisker flow of the variable winds in temperate latitudes, at that season when the Moon becomes vertical to them, than when she is in the other hemisphere. We want indeed, on this point, the concurrent testimony of observations made in some temperate climate, South of the Equator: though we know already that their **polar** winds raise the Barometer, while the **Equatorial** depress it; following the same law as with us, though moving in an opposite direction.

The air which flows from the North and South towards the Equator, is felt as an Easterly wind, because it comes from parts of the earth's surface, which have a smaller motion from West to East, than the region into which it is entering; but it gradually acquires the rotary velocity proper to that region. In returning to the temperate latitudes, it has again to lose this Westerly momentum: and this seems to be the principal cause of the great preponderance of Westerly winds in our own climate. We have seen, p.49, that on a mean of ten years, the Westerly were to the Easterly winds as 225 to 140; while the Northerly and Southerly winds balanced each other within twenty-one days. A wind, coming to us from a considerable distance South, whatever be its velocity, must therefore be felt as a South-west wind: and as the Trade-winds, at certain seasons, appear to have their subsidiary streams or appendages reaching far into the colder latitudes, so these Tropical Southerly gales occasionally make their inroads upon us with greater violence, and for a longer season than usual. It is not unlikely that the British isles, in consequence of their latitude, and from their being as it were a part of its Western barrier, may be the very part of Europe the most exposed to them. A North-east wind, kept up by rarefaction caused by the sun, must find the easiest course upon land; while a South-west, consisting of air which has to descend upon the earth, and spend the momentum it has acquired in more Southern latitudes, is more likely to get easily over the surface of the ocean, and to be arrested by the asperities of the first extensive fixed surface which it encounters. This state of things prevailed remarkably, near the close of the winter of 1817, after a long course of violent Westerly gales; when, as far as we may judge from the reports of navigators, the North-east current was for many days no further to the South of us than the coast of Portugal, without our feeling even the skirts of it.

It is remarkable nevertheless, that on a Mean of ten years, ending with 1816, and indeed in most of these taken separately, the winds to the North and South of West should so nearly balance each other, as that their averages stand 100 : 104. I know of no reason which can be given for this, equally satisfactory with that of their receiving a direction to North and South alternately, by the Moon's different positions in declination: an effect which, although not to be found in the winds of a particular district, in every Lunar revolution, is yet detected in a long average.

On the whole, it may be inferred that the winds in a temperate latitude like our own, after escaping from the Tropical vortex, become subject, in winter more especially, to the Moon; and that their tendency is, to follow her path, or the moveable point of greater rarefaction which she marks out for them. Thus it appears from the statement, p.122, that during her approach to these latitudes, in declination, in 1807 and 1816, the winds from the West and North-west fell off in number. Now if we consider that the Moon's daily course from East to West (which though only apparent has here the same effect as the real,) was coupled, during these weeks, with a motion from South to North in declination, it will appear that a South-east wind would now, in effect, follow her course, and a North-west flow in opposition to it. And in 1816, during the weeks in which the Moon was receding in declination to the Southward, and thus offering daily less and less resistance to a North-west wind, this class of winds amounted to double the number which they exhibited in the former case. Again, in both years, and especially in 1807, the class of winds from North to East, which are plainly most influenced by the Sun, appeared in the greatest number while the Moon was in Full South declination, and when consequently there was little of the rarefaction, which she is here supposed to produce, in these latitudes.

The succession and proportion of the winds are consequently subject to a periodical variation from year to year: but the period in which the same or a similar set of winds comes round again, cannot at present even be conjectured. From the effects produced, in our district, on the average temperature of the years, and on the depth of rain, it may seem to have some connexion with the Lunar cycle of eighteen years. But this is a subject well worthy of separate and more deliberate investigation. In what I have brought forward, I consider myself to have redeemed the pledge given in the **Introduction** to this work. I think I have decided in the affirmative (as regards the phenomena of our own district,) the first part of the question there proposed, "**whether** the relative positions of the Moon, in the different parts of her complex orbit, influence the state of our atmosphere." I have also thrown "some light" on the second part, which proposes to inquire "in what way" this effect is produced. Should it prove so much as shall suffice to stimulate the ambition of Astronomers, in different parts of the world, to annex to the stupendous field of their present labours this lower (if they please so to consider it) and almost uncultivated province, my purpose will be answered; and I have no doubt the consequences will be beneficial to mankind. For although it be a very just remark, that the seasons would not only not go on better for our purposes, but would be in utter confusion, had mankind the **ordering** of them; it does not thence follow that, could we calculate their periods and foresee their extremes, both our personal safety and comfort, and the success of our labours, might not be essentially promoted by such foreknowledge.

An ample, extensive, and accurate collection of facts for each climate, is therefore the first **desideratum**. These should be digested by each observer from his own observations, or from those made in his own district at least: where his local knowledge may greatly facilitate the work. They may be cast either into the forms I have here adopted, or into such others as may be preferred; but as much as possible in a way to be comparable with the results of others. The materials will be found more ample than many would suppose them. To give a single prominent instance, the "Meteorological Observations made at the Royal Observatory at Paris" contain a mine of treasure which it would require years of labour for any single person to explore, in the way in which I have gone through my own and the adjunct Observations, belonging to our London district. And I have no reason to think, from the appearance of the few parts I have examined of those belonging to Paris, that their results would be less regular and systematic than those contained in this Volume.

It will be necessary, before this section be dismissed, to give some account of the general Tables F and G, at the end, entitled "Mean Results of Lunar periods arranged by the Solar year." Wishing to collect, in some part of the work, the Results of the Barometer and Thermometer, for the Lunar periods in which my observations had been published, I cast them into the form there exhibited; putting, as nearly as possible, all those which comprised the Solstitial and Equinoctial points under each other in the same column, and throwing a few periods into a kind of intercalary space at the ends for this purpose. The date and extent of each of these periods may be found at once, by referring to the Table under the number. They vary in each column, as to date, through a space of not less than twenty-five, nor more than twenty-nine days: consequently each column ranges through a mean space of fifty-five days: the intercalary results, however, which are cast, in the following averages, along with the first and last columns, add somewhat to the extent of those columns.

The only use which I shall make of these Tables at present is, to give the results of the first ten years in quarterly averages, and deduce some consequences from them. The reader will however notice the regular gradations which the averages at the foot of each Table present; on which subject, as it respects the several months of the year, I have already treated.

AVERAGES OF TEMPERATURE FOR THIRTY-EIGHT LUNAR REVOLUTIONS, BEGINNING AT NEW MOON, AND FOR EIGHTY-SIX, BEGINNING AT LAST QUARTER, THE WHOLE COMPREHENDED IN A SPACE OF TEN SOLAR YEARS; FROM THE 10TH OF TWELFTH MO. DEC. 1806, TO THE 11TH OF THE SAME, 1816.

1. **Brumal periods**.

Average of ten periods, in the second column and two intercalary	37.92°
Of ten in third column ………….………………….	35.73
Of ten in fourth column ……………………………	39.63
Of thirty two periods ……………………………….	37.76

Below the Autumnal 11.61°

2. **Vernal periods**.

Average of ten in the fifth column ……………………………	42.25°
Of ten in sixth column ………….………………….	48.92
Of ten in seventh column ………………………..…	55.67
Of thirty periods ……………………………………	48.94

Below the Brumal 11.18°

3. **Estival periods**.

Average of ten in the eighth column ………………………….	58.62°
Of ten in ninth column ………….………………	62.39
Of ten in tenth column …………………………….	60.99
Of thirty periods ………………………………. …..	60.66

Below the Vernal 11.72°

4. **Autumnal periods**.

Average of ten in the eleventh column ……………………….	56.70°
Of ten in twelfth column ………….………………	50.75
Of ten in thirteenth and two intercalary …………….	40.68
Of thirty two periods ……………………………….	49.37

Below the Estival 11.29°

AVERAGES OF THE BAROMETER FOR ONE HUNDRED AND TWENTY-FOUR LUNAR PERIODS, BEGINNING AND ENDING AS BEFORE RESPECTING TEMPERATURE.

1. **Brumal periods**.

Average of ten periods, in the second column and two intercalary	29.745 in.
Of ten in third column …………..………………….	29.788
Of ten in fourth column ……………………………	29.874
Of thirty two periods ……………………………….	29.802

Above the Autumnal .021 in.

2. **Vernal periods**.

Average of ten in the fifth column ……………………………	29.870 in.
Of ten in sixth column …………..………………….	29.814
Of ten in seventh column ………………………..…	29.812
Of thirty periods ……………………………………	29.832

Above the Brumal .030 in.

3. **Estival periods**.

Average of ten in the eighth column ………………………….	29.899 in.
Of ten in ninth column …………...………………	29.879
Of ten in tenth column …………………………….	29.854
Of thirty periods ………………………………. …..	29.877

Above the Vernal .045 in.

4. **Autumnal periods**.

Average of ten in the eleventh column ……………………….	29.883 in.
Of ten in twelfth column …………...………………	29.736
Of ten in thirteenth and two intercalary …………….	29.725
Of thirty two periods ……………………………….	29.781

Below the Estival .096 in.

I consider that by this mode of averaging the **Temperature**, the inequalities, or deviations from the Mean of the season, which I suppose to be produced by the Moon's power over the winds, and which are sufficiently apparent (to the extent, indeed, of ten or twelve degrees in most of the columns) in Table G, are completely done away; and the Temperature restored to the course which it ought to have, by the action of the Sun's power alone. The four quarters, accordingly, rise and fall in nearly equal progression; each being, on a mean, 11.45° warmer or colder than the preceding quarter.

I consider that, by the same method, the Lunar influence on the **Barometer** is also done away, and the averages of this instrument brought, in Table F, to the state in which they would be found, in each season, had the Moon nothing to do with them. Any remaining inequalities may therefore be fairly attributed to the temperature, and to what may be termed the Solar succession of the different classes of winds through the year; which is exhibited, as to the calendar months, over the diagram of the rain, on p.70.

Under these circumstances, while the Temperature of the several quarters rises and falls in regular progression, the inequalities of the Barometrical heights follow a very different rule. The winter Barometer gains, in its average, .021 in. upon the Autumnal; the Vernal .030 in. or half as much more, upon the Winter; the Summer 0.45 in. or half as much more still, upon the Vernal; but in the Autumnal average, the whole difference is lost again, and the Barometer comes back to its lowest level.

Now, with regard to the seasons in which the Barometer stands highest and lowest, much may be attributed to the reigning winds.

Thus, the first Estival result, which is the highest of the whole series, lies in the midst of the W-N winds; and the two latter Autumnal ones, in which the mean is depressed to its lowest point, come after a long course of predominant S-W winds. Again the N-E class may be thought gradually to elevate the Brumal periods, and keep up that in which the Vernal Equinox is included; while a subsequent mixture of Southerly winds, in the spring, gives occasion to some depression before the return of the high mean about the Solstice.

But there is a probable cause for this gradation which must not be overlooked, and which has in fact an equal claim with the winds to consideration. The mean state of the Barometer in any moderate district, it is well known, does not represent the [variations of the] weight of the air in that district alone, but [also in a less degree those] for a great extent around it; in which extent different winds may even be found to predominate through the same period of time. And no reason can be given, more appropriate, why the Barometer should [continue to] rise under a certain course of winds, than that the atmosphere is then receiving [throughout the space in question] an [external] addition to its ponderable mass; or why it should fall, under another course, than that it is then sustaining a loss in this respect. The loss and the gain consist in water; which is at one time converted into vapour, permanent as a part of the atmosphere for the season, at another dismissed in rain. Now, in the **Brumal** quarter, where we find the average of the Barometer lowest, the Temperature is lowest also; and there is every reason to conclude that the atmosphere in our district, and for many degrees of latitude and longitude around us, contains, at this season, the lowest proportion of ponderable vapour. As the spring comes on, in these latitudes, and the air acquires heat upwards, it acquires also vapour, and therefore weighs more on a mean than in winter. In the summer months, yet more heat and more vapour are accumulated; and the weight of the whole atmosphere attains its maximum. The addition in each of these seasons is in a greater proportion than that of the heat; probably because the higher the latter ascends, and the more rare the medium is in which the vapour is diffused, the greater the quantity which an equal addition of heat can maintain in its elastic form. At length comes the Autumn, in the course of which the Sun retires to the Southward, the atmosphere of these latitudes cools and is condensed throughout, a great proportion of the vapour it held is decomposed, and its water deposited in extensive heavy rains; and the air, losing this portion of its mass, returns to its former low state of gravity.

Such are the considerations which it seemed needful to take into view, along with the succession of the winds, in accounting for this gradation in the mean height of the Barometer. Should they be founded in fact, a similar gradation will be discovered, by using similar averages, in correct Registers of the Barometer for nearly every part of Europe.

AVERAGES OF TEMPERATURE FOR THE LUNAR REVOLUTIONS CONTAINED IN A PERIOD OF SEVEN YEARS; FROM THE 9TH OF DEC. 1816, TO 6TH OF DEC. 1823. See the General Table, G2.

1. **Brumal periods**.

Average of seven revolutions in the first column and three weeks intercalary	36.62°
Of seven in the second column…….………..………………….	35.78
Of seven in the third column .………………..…………………	39.44
Of twenty-one revolutions three quarters…………………..……….	37.28

Below the Autumnal 12.50°

2. **Vernal periods**.

Average of seven revolutions in the fourth column………………………	43.80°
Of seven in the fifth column ………………..………………….	49.07
Of seven in the sixth column and two weeks intercalary ……..…	57.62
Of twenty-one revolutions and a half……………………………	50.16

Above the Brumal 12.88°

3. **Estival periods**.

Average of seven revolutions in the seventh columns………………….	60.61°
Of seven in the eighth column …..…………..………………	62.75
Of seven in the ninth column ……………………………….	60.72
Of twenty-one revolutions ……………………………..….	61.36

Above the Vernal 11.20°

4. **Autumnal periods**.

Average of seven revolutions in the tenth column……………………….	56.89°
Of seven in the eleventh column ……..………..………………	48.66
Of seven in sixth column with five weeks intercalary ………….	43.29
Of twenty-two revolutions and a quarter……………………….	49.78

Below the Estival 11.58°

AVERAGES OF THE BAROMETER, CONSTRUCTED AS BEFORE FOR THE TEMPERATURE, AND FOR THE SAME PERIOD OF SEVEN YEARS, FROM 1817 TO 1823 INCLUSIVE. See the General Table, F2.

1. **Brumal periods**.

Average of seven revolutions in the first column and three weeks intercalary	29.776 in.
Of seven in the second column…….………..………………….	29.835
Of seven in the third column ………………….…………………	29.723
Of twenty-one revolutions three quarters……………….……….	29.778

Below the Autumnal .055 in.

2. **Vernal periods**.

Average of seven revolutions in the fourth column………………………	29.824 in.
Of seven in the fifth column ………………..………………….	29.784
Of seven in the sixth column and two weeks intercalary ……..…	29.831
Of twenty-one revolutions and a half……………………………	29.800

Above the Brumal .022 in.

3. **Estival periods**.

Average of seven revolutions in the seventh columns………………….	29.904 in.
Of seven in the eighth column …..…………..………………	29.904
Of seven in the ninth column ……………………………….	29.841
Of twenty-one revolutions ……………………………….….	29.883

Above the Vernal .083 in.

4. **Autumnal periods**.

Average of seven revolutions in the tenth column……………………….	29.884 in.
Of seven in the eleventh column …….………..………………	29.743
Of seven in sixth column with five weeks intercalary ………….	29.814
Of twenty-two revolutions and a quarter……………………….	29.833

Below the Estival .050 in.

The General Results presented by the Decade are, here again, confirmed in the Septenary; but with some peculiar variations, which it will be proper I should notice.

1. The progression of the rise and fall of the **Mean temperatures** of the four quarters is not, in the Septenary, so regular as in the Decade. The **Brumal** quarter falls below the Autumnal, full three quarters of a degree more in the former than in the latter; and the loss is recovered in the **Vernal** by a proportionate excess in the advancing temperature. If we look into particular periods we shall find the excess of depression chiefly in the second Autumnal of the Septenary, where it goes so far as that an addition of three degrees (by which the third Autumnal exceeds in the Septenary) is required in compensation. **Thus we have for the Septenary the feature of a colder Autumn**, than belongs to the Decade.

Again, both the several Mean results, and the General average, of the Vernal quarter, exceeds in the Septenary, by about a degree and a quarter; giving to the latter the additional peculiarity of a **warmer Spring**. The **Estival** quarter of the Septenary shows again a superiority in heat of about three quarters of a degree — though the Mean of the year, deduced from the twelve results put down, comes out a third of a degree lower.

2. As to the **Barometrical** results, the progression of the rise and fall differs — the principle of the higher Mean of the Summer being still preserved. Instead of a gradual increase of the mean weight of the atmosphere up to the end of the Estival period, and then a speedy loss of weight, to the whole amount, we have, in the Septenary, an addition in the spring, and a much more considerable one in the summer: which increase goes off in about equal proportions in the autumn and winter.

Thus the warmer Spring and Summer are proved, also, to have sustained **a greater weight of vapour**; requiring, as it seems, a larger space of time to be decomposed and reduced in.

OF THE PROBABILITY OF A COMMUNICATION OF HEAT BETWIXT THE EARTH AND THE MOON BY RADIATION.

IT may perhaps be worth while to include, in any future researches into the variations of temperature connected with the Moon's positions, the question whether there exists any communication of heat between the two planets **by radiation**. It is a received opinion, but I doubt whether founded on any experiments sufficiently accurate or delicate, that the rays of light which we derive, by reflection, from the Moon, bring no portion of heat whatsoever along with them.

The two Planets are certainly very differently circumstanced as to temperature. The Moon being so much the smaller body, and presenting in consequence a much more convex face to the Sun, would, if it were acted upon in the same manner by the Sun's rays, derive from them less heat, and possess in consequence a lower mean temperature than the Earth. But the surface of this planet is presented after a very different manner to the influence of the solar rays. From the time that they impinge on any given part in longitude to the time of their quitting it, a period elapses, equal to twenty-nine of our mean daily periods of sunshine. And the same part, having once emerged from the rays, has an equally long space allowed it to cool again, in uninterrupted darkness. Moreover the rays, which thus act through a day of two weeks' duration, are not as in the case of our polar regions, very obliquely received; but fall on a considerable portion of the surface more or less directly. The effect of this arrangement must be, that the middle regions of the Moon, at least, would experience **the extremes of heat and cold**, in a way to which no part of the Earth's surface can afford a parallel — unless the vicinity of the latter should prove, by reciprocal radiation, the means of equalising the temperature, in some degree, in both planets.

I mean simply to state it as **possible** that the Full Moon, with a surface intensely heated by the Sun, may radiate a portion of heat to the colder parts of the Earth's surface towards the poles; more especially when in her extreme North and South declination: and, on the contrary, that the New Moon, having become proportionately cold on the surface opposed to us, may receive by radiation from the Earth, and especially from the Tropical regions, a compensating degree of heat; which may serve to moderate the rigour of the nocturnal cold on that planet. These are the extreme cases: but if we admit the principle, there will ensue various modifications of the effects; according to the different relative positions of the two planets, and of both with respect to the Sun.

It would be premature, while only two years of observations in our own district have been examined, to attempt to apply this theory to the facts. There is, however, something so remarkable in the regularity of the increase and decrease of the Mean temperature, according to the different Lunar positions, in 1807 and 1816, as stated a few pages back, that it will certainly be desirable to examine, whether any thing parallel to it exists in other climates, more especially in the Tropical regions; as well as what aspect the remaining years of the series present, in this respect, in our own.

To ascertain, in a more satisfactory manner, whether there exists any radiation between the two planets, I would propose that trial be made with **concave metallic mirrors**, having the bulb of a very sensible Thermometer in the focus; in the manner in which several instructive experiments have been conducted, on radiation among terrestrial bodies. It is not at all likely that **glass lenses** should detect so delicate an effect as the one in question. If the principle here supposed be real, the rays of the Full Moon, received in the direction of the axis, should raise the temperature in the focus of the mirror some degrees, in a high Northern latitude; and depress it, in situations near the Equator: due attention being paid in both cases, to insulate the Thermometer, and secure, as much as possible, a stationary temperature in the surrounding medium.

A curious phenomenon resulting from the play of light between the two planets, is so obvious to common notice, that I am surprised not to have met with any sufficient explanation of it. In the interval between the New Moon and First Quarter, when the Moon is seen in the Western sky after sunset, the dark part of the disk, between the cusps and all round the hemisphere, is sometimes so far enlightened as to be not only visible but conspicuous; and in an equally clear sky at other times, this portion of the disk in the same situation is not to be discovered. It appears that the sunshine in our planet is first reflected to the dark part of the Moon, and from thence back to the eye of the spectator: and the reason why this effect is at times (and only at times) sufficient to render the whole disk visible, may be, **that there is then an extensive surface of snow on the Northern American continent**. It will be found, on trial with a globe, that while we are contemplating the Moon in the position above mentioned, the Sun is yet sufficiently elevated over those parts of the world, for the snows to reflect its beams very copiously to the Moon's surface. Some observations, made since this appearance first began to attract my notice, compared with the accounts of the fall of snow in America, have given the matter sufficient importance in my view, to induce me to throw it out as a conjecture.-

ON WHIRLWINDS, WATERSPOUTS, AND SOME ELECTRICAL PHENOMENA CONNECTED WITH CLOUDS.

IT has been shown in the Essay on the Modifications of Clouds, and in the preceding one on Rain, that Clouds are **Electric Aggregates**, floating in an Atmosphere which is itself Electric; and that both are, in a low degree, (in the state in which we commonly observe them,) also **conductors**. A dry air, hypothetically considered, is a non-conductor; but in such an air no cloud could exist. These aggregates float in a region interposed between a saturated medium above, and a medium recipient of vapour beneath them. Hence a great variety of appearances, arising from the passage, or even from the mere influential effects of accumulated Electricity, among them. The rapid changes undergone, at times, by the higher Modifications, extended in sheets in a somewhat conducting medium, point out clearly the fact of this horizontal transmission of the Electric fluid to great distances through the air. I have often considered the bars of cloud, which I have seen to stretch from horizon to horizon, in winter, as conductors between a positive surface, where **snow** perhaps was lying, and one in a state to receive its excess, (as that of the open sea,) at a distance. In this case a degree of **Magnetic power** is also undoubtedly present, and contributing to the effect. And the succeeding winds are often observed to take the direction indicated by these natural pointers, above.

When a large mass of atmosphere is filled to a great depth with a hazy precipitation, having in it a positive charge, the denser clouds generated from the vapour continually emitted from below, (for these, so contrary effects according to our previous notions, often co-exist,) tend to become the conductors of the vast Electric charge to the earth. The Cumuli spread out their superior part, and present it in the form of Cumulostratus, in order to the union, while the haze subsides and thickens; and we witness, here, the amusing process of **Inosculation**; which often terminates in a shower. Even the magnificent Thunder-cloud, before it strikes, has begun to extend a broad summit to the influence above, to which it now serves (as the coating of the glass of the Leyden jar) for a conductor: and in proportion as it becomes a more perfect one, and loses its first state of a charged and insulated body, we see it assume the structure of the **Nimbus**. In this lofty aggregate, so wonderfully disposed for opening a direct communication between the highest region where there can exist any charge, and the earth, we may behold, at times, the passage of the fluid, plainly indicated by the vivid light diffused through the Cirrose crown, and marking out its form amidst the crowded group around it. Often have I viewed this process with intense interest for hours together; at a time when I was more addicted to the observation of nature, and before curiosity had been in great measure sated by these entertainments.

But there are circumstances of relation in their Electric charges, between the higher atmosphere and the surface of the sea or earth, which do not admit of these deliberate preparations: or rather, in which they have already taken place unobserved — where the **cloud** is suddenly made at once the source of a plentiful condensation, and the conductor of a powerful Electricity, without a single previous discharge. The body of conducting rain in the Nimbus, which, as we have seen in the foregoing paper, consists of a positive column, surrounded by a negative cylinder, with the usual outer appurtenances of such a system, becomes now a **twisted moving cord**, **or natural chain**, through which the fluid rushes down suddenly, and with abundantly greater manifestations of the mysterious energies in which it takes its origin. The **Spout**, by sea or land, and the **Tornado**, **with hail and thunder**, come under this description of effects.

The phraseology in general use for these is at present rather confused, and requires its terms to be fixed with greater precision.

1. The term **Nimbus**, for a cloud giving rain, is clearly authorised by the best Latin writers. Then, as to the rain, *Pluvia*, (which seems to have been the adjective *pluvia*, quasi *plus via*; more water than **has way**,) may be appropriated to local **showers**, from definite masses of cloud; whilst *Imber*, *Imbres*, **the rains**, may denote a more general and extensive precipitation of water: *Tonitrus*, *tonitrua*, **thunder** (as to the sound:) *fulgor*, **lightning**; *fulmen*, **a stroke of thunder**. What are called **Fire-balls**, in the accounts commonly given of thunder-storms, I believe are merely the body of electric matter, moving so slowly that its form may be distinctly seen in the passage; which is not commonly the case.

2. ***Ecnephias***, (from *ek nephos*, Gr. **proceeding from a cloud**) seems appropriate to the sudden gusts which precede and accompany showers and thunder-storms; as well as to the more dangerous occasional winds of the same kind, which our seamen denominate **squalls**, and the French *coups de vent*: though in this language they seem to have a sea-term, *bouillar*, applicable to wind and rain in connexion. Our seamen also speak of black and white, or **wet** and **dry** squalls: and it is obvious that a cloud, moving swiftly along with a column of rain, snow or hail under it, must occasion appearances and movements in the air, differing according to the position of the observer, with respect to the shower and its course. Should the term I propose be adopted as a generic one, it may be thus defined; **Ecnephias***: Ventus, fortis, breve et subito ev Nimbo erumpens*. Some attendant circumstances might be added, to denote the species; thus, the phenomena described under Tab. XXXII would be, **Ecnephias***, cum magnâ grandine tonitruis et fulgoribus*: and we might have **Ecnephias** *pluvia*, a squall with rain, *sicca*, a dry or white squall*, nivosa, grandinosa*; and possibly other modifications.

3. ***Turbo***: a whirlwind. *Tourbillon*, Fr. This term might likewise be made generic, and variously modified by additions, in the manner of the last. The phenomenon described under Tab. XCIV and denominated by the relator a **Tornado**, would then be, **Turbo**, *cum maximâ grandine, tonitruis et fulgoribus*.

I suppose the present, as well as the last-mentioned case, of a strong wind combined with the highest manifestations of electrical action, to be the result of a peculiarly rapid and abundant condensation of vapour above the clouds: in consequence of which, there is not time afforded for the regular, balanced arrangements of a thunder-cloud: which might have given repeated discharges to the earth, and thus have relieved the higher atmosphere. On the contrary, there is probably a sudden rushing down of the Electric fluid, together with the vapour, through the imperfect conductors which may be present; and which are assisted in their office by a further, almost instantaneous, condensation during the passage. It is obvious, if we consider the nature of Electrical attraction, that in this case the course of the fluid may determine that of the air; and make it flow during the discharge, either in a violent narrow stream horizontally, with a counter-current above or beside it; or in two whirlwinds, the one descending from the clouds upon the superinduced surface, the other ascending to restore the equilibrium. And even in the latter case, the horizontal movement of the phenomenon may be accounted for, by its speedily saturating the first spot on which it falls, which then repelling it, the shower moves to another; and so on, in a line or track of the breadth of the cloud, and extended in length, according to the time taken by the continuous discharge.

4. ***Typhon***. Def. *Maximus ventorum fortium concursus*. *Ouragan*, Fr. A hurricane: what is probably more strictly the application of the term **tornado**; when the wind having blown with extraordinary violence from one quarter for a while, shifts to another, and so round, till its violence abates. See Tab. LXXXIV and CXXXVI. This genus again, may be made, by short descriptive epithets, to comprehend different species. **Hurricanes** are almost always attended, I believe, with electrical manifestations; and occasionally with a great variety of them. In an account which I possess in manuscript, (I know not from whence extracted,) of the tremendous one in the West Indies, in 1772, the writer says, "I must still mention how dreadful every thing looked in this, in itself, horrible and dark night; there being so many fiery meteors in the air, which I and others who were in the same

situation were spectators of. Towards the East, the face of the heavens presented to our view a number of **fiery rods** (electrical brushes?) which were through the whole night shooting and darting in all directions; likewise **fiery balls** (bolides?) which flew up and down, here and there, and burst into a number of small pieces, and flew to and fro like torches of straw, and came very near where we lay in the road. This was the state of the air over the town: in other parts, **another sort** of fiery balls flew through the air with great rapidity; and notwithstanding all these phenomena, common **thunder** and **lightning** was abundantly great." This account is dated, West end of Santa Cruz (Antigua) and signed, M. Smith. I have no reason to doubt its authenticity.

5. ***Trombus***. The Waterspout. *Trombe*, Fr.

Were it proved that this phenomenon is the mere result of a Whirlwind, it might be denominated *Turbo aquosus*: but I think the accounts we have of Spouts clearly prove them to be, in general, of electrical origin. I suppose the surface of the sea to be superinduced by a great mass of cloud, or condensing vapour above; yet under such circumstances, that the necessary apparatus for regular successive discharges cannot be formed. The watery surface, then, rises in large *papillæ*, and froths up to meet the cloud, while the latter is propagated downward in a lessening cone, to meet the water — and, the passage being thus opened, a portion of the sea-water suddenly rushes up to be dispersed in the cloud, while a copious condensation of the water of the latter is carried in a stream into the sea: the rapidity of the movement, and the resistance of the air, causing one or both streams to assume a whirling motion, in order to effect the passage. The inosculation of a dense Cumulus with a sheet of Cirrostratus above it, which is a common phenomenon, often ending like the Waterspout in rain, may illustrate these more remarkable effects of a stronger charge, existing in a cloud suspended over the sea: and I should define the ***Trombus*** thus, *Mutua inter aquas ad maris superficiem, et in nube proximâ, viribus electricis motas, penetratio*. If there be in nature a phenomenon, which might be fairly brought in argument, in favour of the existence of **two fluids** in Electricity, it is, I think, this of the Waterspout. It is not always, however, the complete Electrical operation here described; and as thunder-storms are on different occasions different processes, with certain common appearances attending them, so the case may be in this instance.

From the same cause (the resistance) which gives to the air a whirling motion, in its sudden ascent in portions rarified by heat, we find, by various accounts, that the water in its frothy state, as well as the cloud, assumes a spiral movement in the column of the spout: the spiral being occasionally seen to climb up around the inner descending portion.

The accounts of the phenomenon, collected in these observations, may be turned to by the Index: in which the Reader will find several illustrations of what has been here stated.

OF SOME LUMINOUS PHENOMENA CONNECTED WITH CLOUDS.

1. **Anthelion**. *Imago solis, a nube oppositâ, quasi ab aquæ superficial, relflexa.*

This is, in effect, the whole history of the Anthelion, that when the surface of a dense cloud presents rightly for the effect, there is the same tendency to reflect the Sun's image, as in a surface of water. Since I first distinctly recognised the phenomenon, I have often been able to trace it, in a greater or less degree of perfection, on the perpendicular sides, or in the recesses between the crown and the foot, of a large Cumulostratus; the cloud being opposite to the Sun at a moderate elevation, and the sky overhead clear. Here we may discover, at intervals, a broad spot of light, much brighter than the rest of the cloud, and proceeding now and then to a momentary circular image, which is presently lost again by the increase, or change of direction, of that part of the surface. This, I have no doubt, is the same kind of reflexion which, under favourable circumstances, has occasionally produced the Sun's image, amidst surrounding clouds in shade, in such brightness as to fix the attention of even a casual observer. See under Tab. CXXX, and Tab. CCXCII. It is sometimes multiple. See under Tab. CXXVIII.

2. **Parhelion**. *Solis species falsa, diversos inter halones in nebulâ effulgens. Plerumque duo vel plures, unà cum ipso Sole emicant.*

Having had few opportunities of seeing **parhelia**, I can only state, that the phenomenon appears to be seated in the points of intersection of different halos; and to derive its brightness from the union of their different reflexions in those parts. A mist near the earth, of very moderate density, surmounted by several Cirrostrati differently inclined to the horizon, may furnish the medium for a perfect exhibition of the **parhelion**; and a frozen state of the particles composing these clouds, is perhaps accessory to the effect. It is a phenomenon which our best observers do not know when to look out for: otherwise we should probably have had a more satisfactory account of its nature and mode of production. See under Tab. CCLXXVIII.

3. **Paraselené**. *Lunæ species falsa, inter diversos halones in nebulâ visa.*

I have never, that I recollect, seen the **paraselené**, but have ventured to make its definition accord with that of parhelion; and to it the same remarks are probably applicable. See Tab. CXXXIII. Note.

4. **Corona**. *Area lucida, sphaeram referens, quæ in nube vel nebulâ circa Lunam nocté videtur.*

The Corona is so common an appearance, when thin stratified clouds are carried over by night, the Moon shining, that I have seldom thought it needful to make a note of it. A circular space full of a mild whitish light surrounds the Moon's disk; and by the passing of the light to some degree of colour (yellowish or brownish) at the outer part, its appearance becomes such as may be compared to a spherical lantern, with the luminary in the midst of it. The phenomenon however varies much, and is only occasionally splendid or conspicuous.

5. **Halo**. *Area lucida, inter duo vel plures circulos inclusa, plerumque colores iridis referens; quæ circa Solent aut Lunam in nube vel nebulâ videtur.*

The **Halo** is less common than the **Corona**, and the Solar much less frequent than the Luna halo. It is a broad circle of variable diameter, sometimes white, but more often exhibiting the prismatic colours; which appears in a thin cloud (**or in a law diffused haze by the help of the cloud's reflection**,) around the Sun's or Moon's disk. Sometimes, more than one circle or series of colours appears at once; and at very different distances from the luminary in the centre.

Coronas and halos, from their connexion with the modification **Cirrostratus**, in which they chiefly appear, are found to indicate wind and rain; sometimes (at the approach of winter) snow and frost, when they are high coloured: and again, late in the spring, I have repeatedly observed a large **white** Lunar halo to be followed merely by hot weather.

6. **Iridula**. *Area circularis in quâ colores iridis emicant, guttulis roris, super gramina vel aranea campestria sparsis, reflexa.*

I have ventured to adopt this diminutive, in order to apply it as a generic term to those little representations of the bow, which are commonly met with in autumn, formed by the dew-drops on the grass, the gossamer, &c.

7. **Iris**.

This term may be made to comprehend at least three modifications.

Iris *Arcus pluvius*: the Rainbow: of which the more rare kind, exhibited in a shower by the light of the Moon, may be distinguished by the addition of the epithet *nocté* or *nocturnus*. See Tab. XXVI, CXXXVIII, LXVIII. **Notes**.

It is unnecessary to define this very common phenomenon. I may just remark here, that an opinion which has been advanced by Dr. Watt in Thomson's Annals, that the **refraction** takes place, not in the raining cloud, but on the edge of another, situate between it and the Sun, appears to me altogether unfounded.

Iris *Arcus nebulæ*: the white or colourless bow, seen in a mist without rain. See Tab. XXX, LXXV.

Iris **Gloria**: Def. *Umbrâ spectatoris in nubem projectâ, circulos, colores iridis referentes, quasi circum caput suum pictos, in nube videt.* **A glory**.

This curious phenomenon is well described and figured, in a paper by Dr. Haygarth, in the Manchester Society's Memoirs, Vol. III. p.463; as he observed it in the year 1780, in the vale of Clwyd. I should not, however, have thought of introducing the definition, had it not fallen to my lot to see it myself.

On the 29th of the Seventh month, 1820, at Folkestone, Kent, the day was fine, with the Barometer at thirty inches, and the wind Easterly. There was a mist, of the kind which I commonly refer to the **Cirrostratus**, resting the whole forenoon on the cliffs toward Dover, and on the high land North of the town. Towards evening, the mist subsided from the cliffs, and appeared on the sea below them; a body of cloud, which appeared to be **Cumulostratus**, showing itself also close to the horizon, on the high land above mentioned.

About half-past six, p.m. walking with my family towards Sandgate, West of the town, we perceived that the mist on the sea was advancing and spreading itself Westward, and towards the shore; and a body of it came at length close under the sandy cliff, on which we stood, at the height of about a hundred and forty feet from the sea. The mist was of various depths: a brig near the shore was at intervals completely hidden by it, up to her topmasts: it exhibited a mixture of **Cumulus** and **Cirrostratus**. In this state of things, the sun shining clear above the Western horizon, our shadows were projected, together with that of the cliff's edge, upon the cloud beneath, on the surface of which, at the same time, each person could perceive, around the upper part of one of the shadows (which being distant were small, and rather indistinctly shaped) a luminous **corona**, surrounded by two faintly-coloured **halos**. The outer halo was very large, compared with our shadows: it surrounded the whole group, and a considerable part of the circle was cut off by the shadow of the cliff. Consequently, when one of the party removed to a distance, his shadow was seen to pass the circle and appear by itself, without the **glory**; notwithstanding which **he** continued to perceive the whole of the phenomenon for himself, around his own shadow; those of the rest appearing to him at a distance, and also without it. We were able to continue these observations for about twenty minutes; until, the Sun approaching the horizon, the shadows became too distant to be perceived, and the circles vanished. A Thunder-storm followed these appearances, in the night of the 30th: after which we had again fine weather. The whole phenomenon was highly curious and interesting; and the facility with which each of the party could either appropriate the **glory** to himself or share it with the company present, suggested to me some reflections of a **moral** nature — in which, however, I shall not anticipate the reader.

ON PROGNOSTICS OF THE WEATHER, DRAWN FROM NATURAL APPEARANCES.

I HAVE treated of several of these in the course of my Observations, detailed in my second and third volumes, and do not propose to enter upon a general consideration of them in this part of the work. They have been very fully collected by Dr. Forster, in his *Researches about Atmospherical Phenomena,* Second Edit. 1815; and in his Notes on **Aratus**: to which the Reader may be referred. But having, myself, made more use of **Virgil** on this subject, I had intended presenting a prose translation, of my own, of that part of the first **Georgic**, in which they are included. Having accordingly given my MS of this version, in a note book, to a young man nearly related to me, to copy out, he brought me after some days, instead of the prose copy, the following; which, with a few touches of improvement of my own, I substitute.

TRANSLATION INTO ENGLISH BLANK VERSE OF THE FIRST BOOK OF THE GEORGICS. LINE 350-465.

Ackworth, 1832

All that the genial year successive brings,
Showers, and the reign of heat, and freezing gales,
Appointed signs foreshow; the Sire of all
Decreed the omens of the varying moon:
Decreed what sign the southern blast should bring;
That hinds, observant of the approaching storm,
Might tend their herds more near the sheltering stall.

PROGNOSTICS.- 1. Of Wind.

When storms are brooding—in the leeward gulf
Dash the swell'd waves; the mighty mountains pour
A harsh, dull murmur; far along the beach
Rolls the deep rushing roar; the whispering grove
Betrays the gathering elemental strife.
Scarce will the billows spare the curved keel;
For swift from open sea the cormorants sweep,
With clamorous croak; the ocean-dwelling coot
Sports on the sand; the hern her marshy haunts
Deserting, soars the lofty clouds above:
And oft, when gales impend, the gliding star
Nightly descends athwart the spangled gloom,
And leaves its fire-wake glowing white behind.
Light chaff and leaflets flitting fill the air,
And sportive feathers circle on the lake.

2. Of Rain.
  But when grim Boreas thunders; when the East
And block-wing'd West, roll out the sonorous peal,
The teeming dikes o'erflow the wide champaign,
And seamen furl their dripping sails. The shower,
Forsooth, ne'er took the traveller unawares!
The soaring cranes descried it in the vale,
And shunn'd its coming; heifers gazed aloft,
With nostrils wide drinking the fragrant gale;
Skimm'd the sagacious swallow round the lake,
  And croaking frogs renew'd their old complaint.
Oft too, the ant, from secret chambers, bears
Her eggs — a cherished treasure — o'er the sand,
Along the narrow track her steps have worn.
High vaults the thirsty bow; in wide array
The clamorous rooks* from every pasture rise,
With serried wings. The varied sea-fowl tribes,
And those† that in Cäyster's meadows seek,
Amid the marshy pools, their skulking prey,
Fling the cool plenteous shower upon their wings,
Crouch to the coming wave, sail on its crest,
And idly wash their purity of plume.
The audacious crow, with loud voice, hails the rain,
A lonesome wanderer on the thirsty sand.
Maidens that nightly toil the tangled fleece,
Divine the coining tempest; "in the lamp
Crackles the oil; the gathering wick grows dim."

3. Of Fair Weather.
  Nor less, by sure prognostics, mayst thou learn,
(When rain prevails,) in prospect to behold
Warm suns, and cloudless heavens, around thee smile.
  Brightly the stars shine forth; Cynthia no more
Glimmers obnoxious to her brother's rays;
Nor fleecy clouds float lightly through the sky.
The chosen birds of Thetis, halcyons,‡ now
Spread not their pinions on the sun-bright shore;
Nor swine the bands unloose, and toss the straw.
The clouds, descending, settle on the plain;
While owls forget to chant their evening song,
But watch the sunset from the topmost ridge.
The Merlin§ swims the liquid sky, sublime,

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* "**Corvus**," given "**Raven**," in Ainsworth; but Pennant concludes that the **Rook** must be intended, "no other species of this kind of bird being gregarious."

† Swans

‡ Kingfishers

§ Or perhaps the **Sparrow Hawk**. In the original *Nisus*, while the **Lark** is *Scylla*; in allusion to the following fable, which seems remarkably to refer to the history of **Samson** and **Dalilah**. Nisus was "a king of Megara, son of Mars, (or more probably of Pandion.) He inherited his father's kingdom with his brothers, and received as his portion the country of Megara. The fate of Nisus depended tonally on a yellow lock; which, as long as it continued on his head, according to the words of an oracle, promised him life, and success to his affairs. His daughter Scylla stole away the fatal hair from her father's head while he was asleep, and delivered it to Minos, king of Crete, who was then at war with the Athenians, and had actually besieged Megara. Scylla had, previously to this action, which was the cause of the surrender of Megara, fallen in

While for the purple lock, the lark atones:
Where she, with light wing, cleaves the yielding air,
Her shrieking fell pursuer follows fierce—
The dreaded merlin;- where the merlin soars,
Her fugitive swift pinion cleaves the air.
And now from throat compressed, the rook emits,
Treble or fourfold, his clear piercing cry;*
While oft, amid their high and leafy roosts,
Bursts the responsive note from all the clan,
Thrill'd with unwonted rapture — oh! tis sweet,
When brightning hours allow, to seek again
Their tiny offspring, and their dulcet homes.
  Yet deem I not, that heaven on them bestows
Foresight, or mind above their lowly fate;
But rather, when the changeful climate veers,
Obsequious to the humour of the sky;
When the damp South condenses what was rare,
The dense relaxing — or the stringent North
Rolls back the genial showers, and rules in turn,
The varying impulse fluctuates in their breast:
Hence the full concert in the sprightly mead,-
The bounding flock — the rooks' exulting cry.

4. The Moon's Aspects, &c.
  Mark, with attentive eye, the rapid sun,-
The varying moon that roils its monthly round;
So shalt thou count, not vainly, on the morn;
So the bland aspect of the tranquil night
  Will ne'er beguile thee with insidious calm.
When Luna first her scatter'd fires recalls,
If with blunt horn she holds the dusky air,
Seamen and swains predict th' abundant shower.
If rosy blushes tinge her maiden cheek,
Wind will arise: the golden Phœbe still
Glows with the wind. If, (mark the ominous hour!)
The clear fourth night her lucid disk define,
That day, and all that thence successive spring,
E'en to the finished month, are calm and dry;
And grateful mariners redeem their vows
To Glaucus, Indös, or the Nereid nymph.

5. The Sun's Aspects.
  The sun, too, rising, and at that still hour,
When sinks his tranquil beauty in the main,

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love with Minos; upon seeing him from the walls of the town. Minos disregarded the services of Scylla; and she threw herself into the sea. The gods changed her into a lark; and Nisus assumed the nature of the hawk, at the very moment that he gave himself death, not to fall into the enemy's hands. These two birds have continually been at variance with each other; and Scylla, by her apprehensions at the sight of her father, seems to suffer the punishment which her perfidy deserved." Classical Dictionary.

* Pennant, in his British Zoology, says of the raven, (a kindred species,) "In clear weather they fly in pairs a great height, making a deep loud noise, different from the common croaking. Their scent is remarkably good."

Will give thee tokens; certain tokens all,
Both those that morning brings, and balmy eve.
When cloudy storms deform the rising orb,
Or streaks of vapour in the midst bisect,
Beware of showers, for then the blasting South,
(Foe to the groves, to harvests, and the flock,)
Urges, with turbid pressure, from above.
But when, beneath the dawn, red fingered rays
Through the dense band of clouds diverging, break,
When springs Aurora, pale, from saffron couch,
Ill does the leaf defend the mellowing grape:
Leaps on the noisy roof the plenteous hail,
Fearfully crackling. Nor forget to note,
When Sol departs, his mighty day-task done,
How varied hues oft wander on his brow:
Azure betokens rain: the fiery tint
Is Eurus' herald; if the ruddy blaze
Be dimm'd with spots, then all will wildly rage
With squalls and driving showers: on that fell night,
None shall persuade me on the deep to urge
My perilous course, or quit the sheltering pier.
But if, when day returns, or when retires,
Bright is the orb, then fear no coming rain:
Clear northern airs will fan the quiv'ring grove.
Lastly, the sun will teach th' observant eye
What vesper's hour shall bring;- what clearing wind
Shall waft the clouds slow floating;- what the South
Broods in his humid breast. Who dare belie
The constant sun?-

Of the cause and manner of the swelling and shrinking of wood in a moist and dry air; and of hygrometrical attraction.

In the year 1805, soon after the publication of the Essay on Clouds, I was engaged in a correspondence (involving somewhat of controversy) with my friend John Gough, celebrated as the blind philosopher; then resident near Kendal, where I paid him a visit. I had adopted the hypothesis of **Dalton** on the state of vapour in the Atmosphere, which my friend above mentioned rejected, preferring the notion of a Chemical solution of water in air. And on the subject of **Hygrometry** holding the peculiar doctrine of a **Hygrometrical attraction** between water and the matter of the vegetable [or other substance employed] as the source of the phenomena exhibited by our ordinary hygrometers; and by wood in doors and wainscots, on the approach of a change of weather. The six long letters of this excellent mathematician, which I hold, may be found worthy at some time of publication. With regard to my own part, I shall here only advert to the first point, (respecting vapour,) in explanation; and give some particulars of my case upon the second, which may prove instructive to some of my readers, in a practical way.

The opposition to my friend Dalton from this quarter was so strong, that for a while I yielded to it, so far as to omit his theory in my Essay, as republished in **Rees's Cyclopædia**. In the new Edition of the Modifications, inserted in my Introduction to this work, and also printed separately, I have resumed it; as being after all the most satisfactory to myself: although, as often happens, there was, I believe, a measure of truth on both sides, in the controversy we waged about Evaporation and the state of vapour in the atmosphere.

The swelling of wood is a consequence of the entrance of real liquid water into the fine tubes where the sap before circulated: and its shrinking ensues upon the expulsion of the liquid from these tubes, by the elastic force of the ligneous fibre, tending to resume its former state. The attraction between water and the ligneous matter undoubtedly affects **the surface**, and is concerned in the rotting of the substance of the wood: but it has little to do with this peculiar process, which is wholly a result of the vegetable organization; and continues only while the wood continues in some measure **elastic**. Which property ceasing after some years, by the beginning of a change tending to decay, the wood is pronounced 'seasoned,' and is no longer found to expand and contract as before. See **Introduction**, p.vii for further remarks on the hygrometer in this respect

I proved this fact, I believe, to the satisfaction of my friend, by the following experiments. "I caused a piece of **White deal**, of the most uniform texture and without knots, to be cut into three smooth Cubical blocks of two inches diameter. After being exposed for twenty-four hours to a gentle heat, these weighed as follows: A, 974.75 grains; B, 933.80 grains; C, 1026.60 grains. I covered with a resinous coating [by heat] four out of the six faces of each: leaving exposed — In A, the two faces parallel to the plane of the layers of the wood, or rather to the chord of the arc of these; in B, the two faces perpendicular to this plane [which would have corresponded with a section made into the trunk of the tree from the bark to the pith, lengthwise:] and in C, the two transverse faces lying (as the phrase is) across the grain. The blocks, being again accurately weighed, were placed for twelve hours over water at 60°, in a covered vessel.

"At the end of this time, A was found to have gained 4.40 gr. B, 3.60 gr. C, 13.30 gr. One of the naked surfaces of each being now placed in water, about ⅛ in. deep — in 1½ hour, the blocks had imbibed as follows: A, 3.9 gr. B, 4.2 gr. C, 53.7 gr. And, with 12 hour on the [naked] face, A, 3 gr. B, 2.5 gr. C, 35.4 gr. Being then wholly immersed just below the surface, for eighteen or twenty hours, A imbibed 25 gr., B 26 gr., C 87 gr. Proper care was taken to remove the water adhering to the surfaces, before weighing them.

"The whole of the water imbibed by each cube, **reduced to the standard of 1000 grains of wood**, appeared in round numbers to be, A, 37, B, 38, C, 184 grains. Now, as the wood was all of the same quality, temperature, and dryness, and other circumstances alike, had the attraction been wholly chemical, like that of the caustic Alkalies and Lime, for water, there appears no reason why equal surfaces should not have imbibed equal quantities of water.- But the water imbibed by the several surfaces, appears in direct proportion to the number of sections of these parallel tubes which they [may be conceived to have] presented. The **layers** [from the flexure of the grain] being neither perfectly plane nor parallel.

"The absorption of water by wood and other hygrometrical bodies is, therefore, an effect of their organization; and differs in no respect from the penetration of this fluid into capillary tubes made of glass; except that, here, the tubes are more elastic, and yield sensibly to the force with which the particles of the fluid attract each other, in the direction of the length of the tubes.

"In consequence of this elasticity, the substances [in question] after being distended by water, return to their original dimensions in a dry atmosphere. And this fact furnishes us with a solution of the problem of the entrance of the water, without calling any further action of the atmosphere than is exercised upon a moist pebble or piece of glass [the state of which, again, upon the supervening of a moist air, explains the manner in which the water reaches the apertures of the tubes.] For the evaporation of that part of the water which adheres to the surface will be followed by the gradual expulsion of the remainder; 1. Because the elasticity finds less resistance that way, and so becomes [in its turn] the *vis a tergo*: 2. Because the mouth of the tube, as it becomes emptied by evaporation, ought to attract the water, back again as powerfully as it drew it in. [The whole case sufficiently explains the swelling and shrinking of doors and wainscots: especially the experiment **over** water, in a close vessel.]

"I find that even the thick bottom of a cast-iron pot has pores, which, when the pot is filled with **quicksilver**, become [in time] charged with that fluid. And when the pot has been emptied and bruelied, it will continue to spew out quicksilver from invisible openings for many hours — which is found (to the grew surprise of person unacquainted with the nature of the case) collected in a mass at the bottom.

"As the wood, however, gained weight from the moist air (as well as from the water,) **without a variation of one degree in the Temperature**, it became a question how this water came in substance to the mouths of the tubes. To ascertain this, I was induced to try some further experiments. In the first place, reflecting that Caustic Alkalies and Lime, during their combination with water, give out much Caloric, I concluded that, if there existed any similar attraction in the present subject, it ought to be discoverable by the same effect. Accordingly, 1. I mixed fine dry sawdust with water, each at the Temperature of the atmosphere, and found the Thermometer rise a few degrees in the mixture: 2. By placing a very sensible Thermometer in sawdust, in contact with water, I found this elevation took place at the precise time, when the water in penetrating the sawdust arrived at the Thermometer — that it did not exceed 5°, the substances being about 60°; and that the Thermometer soon fell again, by the contact of the lower water following the first portion. 3. Having pressed a quantity of coarse dry sawdust into the upper part of a pneumatic jar with a narrow neck, I placed the open end in water, a Thermometer being introduced through the neck, with its bulb in the centre of the sawdust. I found in two successive experiments that the water [which did not touch the sawdust] assumed a Temperature 1° **lower** than the air of the room — and the sawdust a temp. 1° **higher**. In the first experiment this was the case for several hours: I made the second merely to be assured of the fact.

"I infer [from this] the fact of a real, though feeble, chemical affinity between the fibre of wood, and water; whereby the wood will decompose vapour. There are many striking facts in proof of a chemical affinity [of the kind,] such as the **firing of ricks**, usually attributed to the vinous fermentation [which indeed begins the process,] and the strong heat excited in heaps of woollen rags left long unopened. To this I attribute the first deposition [where no disparity of temperature exists] of the water on the surface of the wood — yet without admitting it to more than a share of the effect. The atmosphere contains, during the greater part of the year, such a quantity of water in a state of diffusion, as might suffice to produce it.

"Now the swelling and shrinking of [wood and other] hygrometrical bodies being readily accounted for by capillary attraction and elasticity, with the single **datum** [or postulate] of water alternately deposited on their surfaces, and evaporated from them [by changes of temperature,] I think the 'Hygrometrical affinity' may be dispensed with, **as a cause not wanted**. And consequently, that the argument drawn from it, for a similar counter-attraction in the air, should be referred to the original one of a Chemical affinity between air and water, [which was before disproved,] and stand or fall with it."

It follows as a consequence from these facts and experiments, that, to secure wood pannels from swelling by damp, and cracking afterwards — and doors from being set fast — it is not enough to cover the outer surface (or even both surfaces) with a timely coating of paint. **The ends and sides of the panels, where they are let into grooves, should above all be attended to, and well pitched or painted**, to prevent the entrance, that way, of the water, that in spite of other precautions, may occasion this inconvenience.

SUMMARY OF THE PRINCIPAL PHENOMENA OF THE CLIMATE.

LONDON, or the metropolis of the British empire collectively so denominated, is situate towards the western extremity of the plain, or valley, forming the estuary of the Thames. The course of this river is on the whole from West to East, through the city; a little below which, a smaller plain opens to the North, watered by the river Lea, which here falls into the Thames. The sea is distant fifty miles towards the South, with pretty high land between; and about as much towards the East, where the Thames joins it. The site thus described is bounded, except in the direction of the estuary, by rising ground, and by hills of moderate elevation, from which other streams descend into the Thames on each side. The soil is loam and gravel, on a sub-stratum of clay: and the drainage and embankment being perfect, the country, though in some parts considerably wooded, and in others below the level of high-water mark in the river, is dry and healthy.

The latitude being 51°31' N. we enjoy the Sun in the shortest days, for seven hours and three quarters, and in the longest, during sixteen hours and a half.

The **Mean Temperature of the Climate**, under these circumstances, is strictly about 48.50° Fahr.: but in the denser parts of the metropolis, the heat is raised, by the effect of the population and fires, to 50.50°[a]; and it must be proportionately affected in the suburban parts. The excess of the Temperature of the city varies through the year, being least in spring, and greatest in winter; and it belongs, in strictness, to the **nights**; which average three degrees and seven-tenths warmer than in the country; while the heat of the day, owing without doubt to the interception of a portion of the solar rays by a veil of smoke, falls, on a mean of years, about a third of a degree short of that in the open plain.

The Mean Temperature **of the year** is found to vary in different years, to the extent of full **four and a half degrees**; and this variation is periodical. The extent of the periods, for want of a sufficient number of years of accurate observations, cannot at present he fully determined; but they have the appearance of being completed in **seventeen** years. We may consider one of these Cycles, as commencing either with 1790, or 1800, and ending with 1806 or with 1816. See Fig. 1, and the explanation, p.3.

In either case, a year of mean temperature begins the Cycle; in which the **coldest** year falls at the end of ten years, and the **warmest** at the end of seven years, reckoning from the coldest; and thus alternately; both together including a complete revolution of the mean temperature from its higher to its lower extreme — (or *vice versa* from the lower to the higher) and back again. The year 1816, which was the coldest of a Cycle, appears to have had its parallels in 1799 and 1782; and there is every reason to conclude, from present appearances, that the warm temperature of 1806 will re-appear in 1823; which will probably be the warmest, and 1833 the coldest, **upon the whole year**, of a Cycle of seventeen years, beginning with 1807.[b]

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[a] Mean of the Climate, with the city temperature included, taken on thirty-four years, 49.65°: See p.25.

[b] The ascending series, or **Septenary**, has re-appeared, beginning however with 1816, the same year in which the previous Decade ended. See Fig. 9, p.26, and the observations belonging to it. And the **Decade**, which was described as having appeared twice in the course of the Observations, is now running; having commenced with the year 1824. See Fig. 10, p.27,

These extreme Annual temperatures are gradually produced, and chiefly by elevations and depressions of less extent, which take place in alternate years: and as the character of the year, in other respects, follows the mean temperature, it is very desirable to ascertain, whether similar periods of variation exist in the Annual temperature of other European districts, not too remote in latitude and elevation from our own.

The greatest **Heat** to which our climate is subject, in the course of one of these periods, is **ninety-six** degrees:- the greatest **Cold**, **five** degrees **below** zero. Thus the full range of our Temperature is about 100° of Fahrenheit.[c*]

Our Temperature scarcely ever rises above 80° but that the occurrence is followed, either in our own or in some neighbouring district, by a Thunder-storm. These tempests are apt to be more severe and of longer continuance in our plains, than in the more hilly or mountainous districts of the island; the equilibrium between the clouds and the earth being, here, less easily restored. They appear to be a consequence of the irruption, upon our previously calm atmosphere, of the temperate air of the Atlantic; they are followed by more or less of Rain, and by a reduction of the heat for a season.

With regard to the other Extreme, we are so situated, that even in the coldest season of the year, the medium of the twenty-four hours, **upon a long average of years**, does not fall below the freezing point. Continued frost in winter is, consequently, always an exception to the general rule of the climate. The winter even passes, occasionally, almost without frost: in return for which we have, at uncertain intervals, a rigorous season of many weeks' duration, attended with the deep snows, and clear atmosphere, common to more northern latitudes. Our seasons of frost go off, like those of great heat, with a wind from the Atlantic.

The greatest heat falls, on a mean of years, not about the Summer solstice, but at an interval of a month after it, and the greatest cold, at the same interval after the Winter solstice. The mean

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and the Observations. It differs somewhat in its form from the two which go before it: but the great principle of the descending alternation is preserved.

[c] In the years from 1817 to 1831, since elapsed, the Temperature has risen to 97° in the year 1823; and descended to zero in 1820. The Medium between these two is 48.5°, agreeing nearly with the Mean of the Climate in the open plain. See page 45.

*__Note in the 1st Edition.__

In my First volume (Introd. p.xviii) I adverted to the desirableness of our "adopting, by consent, uniform modes, terms, and measures," of observation, in order to render more easy the communication between Meteorologists in different countries, and thus advance the science. This hint has been taken up by the Editor of the Journal de Physique, in a passage of which the following is the substance:- "There continue to be published in Thomson's Annals, the Monthly Meteorological Observations made at Bushy Heath, near Stanmore, by Col. Beaufoy, and at London by Mr. Howard, to whom the science is indebted for the new nomenclature of Clouds, which is generally adopted in England, and already in use in some parts of Germany, though nearly unknown in France."

"Tilloch's Philosophical Magazine, Schweiger's Journal, and Gilbert's Annals, have likewise produced observations of this kind, of which, however interesting, we cannot, for want or room, give an account: we shall therefore content ourselves with observing how important it is, that Meteorologists should be explicit in their account of the manner and time of their observations, and that their Instruments should be comparable with each other. Indeed it would be worth while, in order to secure this point, that a sort of congress of observers should be held, as M. Pictet proposes, to deliberate on the subject. Unless indeed there should appear some elementary treatise, including all the branches of Meteorology, and exhibiting a model, sufficiently well executed to overcome the prepossessions, not of individuals only, but of learned societies and nations; and thus secure for itself universal reception. If we are to expect such a treatise at all, it appears that it must be from the pen of Mr. Howard, of whom we have just made mention; and who, in effect, has published, in the course of this year, the first volume of a work, entitled the **Climate of London**, which appears likely to fulfill the object." Janvier, 1819, p.31.

However willing I may be to contribute what lies in my power, to a general good understanding among the cultivators of this science, I must here, once for all, disclaim in favour of some more qualified leader, the pretensions above described. In the mean time, I may he permitted to advance a modest plea in favour of Fahrenheit's scale of the Thermometer, at present used by British Meteorologists. There is a convenience in its extent, and even in its mode of graduation, which I should be Loath to resign in favour of one, the divisions of which should be either so large, as to require a resort to fractions in every observation; or so minute as to burden the memory, and make it difficult to seize and retain its prominent points and relations. And similar reasons induce me to prefer our own graduation of the **Barometer** to that at present in use at Paris. Yet there is no doubt with me, that our observers would he disposed to sacrifice, in some degree, their convenience and their predilections, for the great object of a common uniform standard.

temperature of the year is, in like manner, developed at an interval of about a month after either equinox. The nature and reason of this curious law, together with the daily gradation of the heat throughout the year, which I have fully treated under the head **Temperature**, does not admit of recapitulation here.*

One of the most remarkable features of our climate is certainly the great **variableness** of the temperature: which departs from the mean in either direction, in the course of a few days, and sometimes in a single day or night, to an extent greatly exceeding, that which the simple presence or absence of the sun, would, at that season, occasion. This appears to be the basis of the so much deprecated tendency to cloudiness and frequent rain; which renders our weather usually unpleasant to persons coming from a more Southern, or even from a Northern clime, if belonging to a continent. Habit, however, completely reconciles the Englishman to a sky, which rarely glows for a week together with the full sun, and which **drips** more or less, on half the days of the year: and he finds, in the vigour inspired by its moderate cold, and in his mental energy, which is kept alive by its incessant changes, an indemnity for any deprivation of the listless animal enjoyment, in which the African and the Asiatic grow weary. Vicinity to the Sun's direct rays is the source of **their sameness**; and singular as it may appear, to those little conversant in such subjects, it is demonstrable, from abundant evidence, (enough of which is even contained in this Volume,) that we owe most of **our vicissitude**, even in temperature, to the **Moon**. It appears that our attendant planet, principally, if not solely, by the effect of gravity, continually disturbs the density of the atmosphere, producing, in the temperate latitudes of the globe, a **variety of currents**; the different qualities of which, in respect of temperature, moisture and electricity, are developed as they successively pass over. Hence great **variety of weather**;- this, however, on the great scale of the year, is regulated by the more or less predominant influence of the Sun, according to his place in declination: which secures to us the enjoyment of our **four seasons** in succession, these minor fluctuations notwithstanding.

Referring to the work at large for their varieties, let us review the Seasons in their **mean** or standard state — and then the **Months** in succession, in their Meteorological properties and relations. It may, however, be repeated here, in order to complete the general standard, that the **mean height of the Barometer**, for the period from 1807 to 1816 inclusive, to which my own results are referable, is 29.823 inches: that of the Royal Society exhibiting for the same period a mean of 29.849 inches.[d]

That the mean annual Rain, at the surface, for the like period is 24.83 inches, and that both a longer average of my own, and the average of the register of the Royal Society for the ten years previous to the above period, **when corrected for the elevation of the gauge**, give a result very near to twenty-five inches.[e]

I have stated that the character of the years, in other respects, follows in great degree the Mean temperature. To apply this to the Rain, it will be found that from 1810 to 1816 inclusive, the **warm** years were uniformly **dry**, or below the average in rain, and the **cold** ones uniformly **wet**, or above the average. It is also remarkable that, after an extreme wet year in 1797, we had four successive years very near the average in rain, and then an extreme dry year: and that the same series appears to be now in repetition from 1816: that very wet year having been already succeeded by three average years, and the fourth, 1820, presenting for the half of it elapsed, the same character: so that there is every reason to presume that 1821 will prove an extreme dry year. Thus the Rain appears to have a

* I have published on a broad sheet, and in anticipation of that part of my subject, a compendious account, illustrated by a diagram, of the principal phenomena of Temperature in the Climate of London. It is entitled **A Companion to the Thermometer**, and may be had of the publisher of this work.

[d] The Mean of the Barometer for the Septenary ending with 1823, was found to be 29.826 in. That for the seven years of the succeeding Decade, elapsed up to 1830, is 29.859 in.; but it is probable this Mean will be lower on the Decade when complete.- See p.38.

[e] The average Annual rain far the twelve years, from 1820 to 1831, is 25.92 in. collected at the Laboratory, Stratford. That for the whole series of **thirty-five** years, from 1797 to 1831, is 25.426 inches. See p.81-82.

cycle of increase and decrease, as well as the Temperature, though it may not be limited to the same extent of years as the former.[f]

The **mean of De Luc's Hygrometer** for the climate is 66 degrees:[g] and the character of its prevailing winds **Westerly**.

OF THE SEASONS.

Our WINTER begins, by the temperature, the 7th of the Twelfth month, **December**, and continues eighty-nine days: in Leap-years, ninety days.

The mean **Temperature** of the **season** in the country is 37.76°* During it, the medium temperature of the twenty-four hours descends from about 40° to 34½ degrees, and returns again to the former point.†

The mean height of the **Barometer** is 29.802 in. being .021 in. above that of Autumn. The range of the column is greatest in this season; and in the course of twenty winters it visits nearly the two extremities of the scale of three inches. The mean Winter range is however 2.25 inches.

The predominant **Winds** at the beginning of winter are the S-W: in the middle, these give place to Northerly winds — after which they prevail again, to the close: they are at this season often boisterous at night.

The mean **Evaporation**, taken in situations which give more than the natural quantity from the surface of the earth (being 30.467 in. on the year) is 3.587 inches. This is a third **less** than the proportion indicated by the Mean temperature; showing the **dampness** of the air at this season.

De Luc's **Hygrometer** averages about 78 degrees.

The average **Rain** is 5.868 [by the long average 5.77] inches. The rain is greatest at the commencement, and it diminishes in rapid proportion to the end. In this, there appears a salutary provision of Divine Intelligence: for had it increased, or even continued as heavy as in the Autumnal months, the water instead of answering the purpose of irrigation, would have descended from the saturated surface of the higher ground in perpetual floods, and wasted for the season the fruitful plains and vallies. See on this subject the Notes under Table XXVIII.

Notwithstanding the sensible indications of moisture, which in the intervals of our short frosts attend this season, the actual quantity of **vapour** in the atmosphere is now, probably, at its lowest proportion. Or rather, it is so at the commencement of the season; after which it gradually increases with the temperature and evaporation.

In consequence of the reduced state of the vapour, and the generally weak Electricity, in mild weather, the Clouds exhibit little variety; and are easily, and therefore frequently, resolved into rain. The **Cirrostratus** and **Cumulostratus**, with abundance of **scud**, or the scattered rudiments of the Cumulus, chiefly appear: the whole sky hangs low, and the region below it to the earth, is more or less **misty**. Yet we are not now wholly exempt from Thunder-storms; which occur, apparently in consequence of the sudden and plentiful decomposition of vapour, brought in by strong Southerly winds.

Hail is, however, of rare occurrence in our winter, if we except a sprinkling of small opake **grains** which in the fore part of the night indicate the approach of a low temperature, and are found on the frozen ground, and on the ponds in the morning.

The **Snow** crystallizes, with us, when slowly and scantily produced, in forms not so various perhaps as those of higher latitudes, yet sufficiently beautiful to be worthy, at all times, of examination: the star of six rays, carrying more or less of secondary branches at an angle of 60°, is

[f] The very wet year 1816, was in effect followed by four years near the average (their **mean** being 24.67 in.) but the very dry season here assigned to 1821 turned out an extreme **wet** one, the produce of the gauge; but an inch below that of 1816; and the extreme dry season followed in the next year.- See p.66 and p.81.

[g] I have nothing very satisfactory of further observation on this Instrument.

* As deduced from the averages in Table G, for the period from 1807 to 1816.

† According to the Table of averages on twenty years, in which the City observations form one half of the period. It descends to 30.70°, on ten years in the country.- see General Tables.

the most common. In this respect also the **Rime**, which collects on our trees and shrubs, when it just freezes with a moist air, presents considerable variety, and is occasionally magnificent. The **Hoar-frost**, which whitens our fields usually at the approach of rain, and is not confined to this season, is of two kinds. The most common is **spicular**, like the rime, and collected in this form from the air; though I have some doubt whether the particles are usually frozen until the moment of their attachment to the support: the other is **granular**, and consists of the drops of dew, beautifully solidified by the cold, as they rest on the herbage.

Our great frosts are preceded by the continued thick **Mists**, from the condensation of the vapour, which continues for some time to be emitted by the rivers and other waters; as well as by the moist soil, until frozen to some depth. I have gone into some detail on the phenomena of our hard and stormy winters, in the Notes under Tables LXXXIX, XC, CI, CII, CXIV, and CXV to which the reader is referred. The simple difference of 4° or 5°, in the medium temperature, suffices sometimes to effect the change from a damp misty state of the air, to comparative dryness and serenity — or the contrary. Our winters, therefore, present every variety of weather which can be expected within the limits of the temperature — from the calm frosty night, with its short day of cheerful sunshine, to the gloomy or thickly clouded sky, when the South-west wind surges among the leafless trees through the nights; or the more dreaded North-east prevails through the twenty-four hours, driving the snow before it.

From the uncertain occurrence of really dangerous weather in our winters, it is probable that the people make less of the needful provision of clothing, use less foresight in their movements, and in effect, suffer more in proportion from the cold, than the inhabitants of higher latitudes.

SPRING commences the 6th of the Third month, March: its duration is 93 days, during which the Medium temperature is elevated, in round numbers, from 40 to 58 degrees. The Mean of the season is 48.94° — the Sun effecting by his approach an advance of 11.18° upon the mean temperature of the winter. This increase is retarded in the fore part of the Spring, by the winds from **North** to **East**, then prevalent; and which form two-thirds of the complement of the season; but proportionately accelerated afterwards by the Southerly winds, with which it terminates. A strong **Evaporation** in the first instance, followed by **Showers** (often with thunder and hail) in the latter, characterize this period. The temperature commonly rises, not by a steady increase from day to day, but by sudden starts; from the breaking in of sunshine upon previous cold cloudy weather. At such times, the vapour appears to be, at times, thrown up, in too great plenty, into the cold region above; where being suddenly decomposed, the temperature falls back for a while, amidst wind, showers, and hail; attended in some instances with frost at night.

I have given, under Table XXXII a detailed account of one of these hail-storms, the ravages of which I myself witnessed. Our own island, however, suffers but little from them, compared with the fine fields of some provinces of France; which from time immemorial have been subject to their destructive visits. Human ingenuity, always exercised in one way or other in an uncertain strife with the elements, has here, however, resorted to a bold and singular expedient; for the French actually blow up the nascent storm with gunpowder! An account of this process, as practised in the high lands of the district of the **Maconnais**, is given under Table VI: and the same page presents an instance, in an accident at Silkstone, **Yorkshire**, (where several persons were drowned by a torrent proceeding from rain in the district above them,) of what may be suffered in a neighbourhood from the want of skilful observation of the gathering of Thunder-storms, and the probable course of the waters which they may discharge, in a mountainous country.

The heat and vapour, notwithstanding these interruptions, accumulate on the whole; and the atmosphere now receives an addition of .030 in. upon the mean of the winter — the Barometer averaging 29.832 inches. But the extreme elevations and depressions of the column go off, in great measure, during the season; and by the end of Spring the range is contracted to about an inch and a half. Mean range of the season 1.81 in.

The Evaporation, taken as before, amounts to 8.856 inches; being about a sixth part **more** than the proportion indicated by the mean Temperature.

Consistently with this proof of **dryness**, the average of De Luc's **Hygrometer** is 61 degrees.

The Mean **Rain** is 4.813 [by the long average 5.23] inches. It increases at a small rate through the season: but being greatly exceeded by the Evaporation, the soil uniformly gets dried; and the light springs, which issued during the winter from the superficial strata, disappear or become insignificant.

The lower atmosphere becomes very transparent in the fore part of the season; but the brilliancy of the returning Sun is apt to be eclipsed, during pretty long intervals, by a close veil of **Cumulo-stratus** clouds, which cover the whole sky with their drapery; connected at certain points by a kind of central stem; or basis of the structure, hanging low in the sky. At other times, under the same course of Easterly or Northerly winds, there appear regular ranks of a meagre **Cumulus**, coming on from the horizon, and passing away to the opposite quarter, with little or no change of form or magnitude; and unattended in great measure with any other modification. But in the latter part of the season we have a greater variety of Clouds. The **Cirrus**, which is connected with variable breezes throughout the year, now assumes more of tint and consistency, and is peculiarly fine before Thunder-storms: and majestic **Nimbi** traverse the sky in succession, affording slight showers of large opake hail or snow; the prodigious Electricity attending which seems to prove, that these singular clouds really act as **conductors**, fitted by communicating a portion of the repulsive fluid, to prepare the way for the descent of subsequent showers; without the necessity of an explosion. See an account of the Electrical phenomena of one of these, under Table VI; by which it appears that the centre of a shower is **positively** charged, while the circumference is **negative**:- a fact which affords a clew for explaining many of the most sudden, and apparently capricious changes, discoverable by the insulated rod, when showers are flying about in distinct bodies; the separate charges of which must, independent of their own composition, produce many phenomena by affecting each other [influentially.]

It is remarkable, that a **Snow-storm**, in the middle of this season, not unfrequently proves the forerunner of the first hot weather; which is developed in ten days, or at most two weeks after it. Consistently with this fact, some of the swallow tribe, of which several species come from the South, to avail themselves of our temperate summers for breeding, (if not also to shun the Tropical rains,) make their first appearance in the midst of such weather. This seems to prove that their approach is not gradual, but rather a rapid flight to our shores by the help of a superior Southerly current: and some observations on the phenomena consequent on their disappearance, induces me to suspect, that they avail themselves of similar aid, from a high Northerly current, to return.

A wet Spring seems not at all ungenial in our climate, provided it be followed by a warm and dry Summer, as was remarkably the case in 1818: but in general, dry weather, however cold in the early part of the season, appears to be the wish of our farmers, who have no objection to showers after they have got their seed into the ground. "Humida solstitia atque hyemes optate serenas agricolæ," says the Latin poet; whose rules in some particulars indicate a climate not so remote from our own, as is that of Mantua at this day. But should the farmer have too much rain for the business in which he is now occupied, it may be some consolation to him to be satisfied (as he may in general) that the circumstance indicates a dry time for the ensuing harvest. I have shown, in page 74, in what years during my own observations, a portion of the rain usually belonging to the Autumnal equinox, was thus anticipated by the Vernal.

SUMMER begins the 7th of the Sixth month, **June**, and lasts ninety-three days. The Mean **temperature** of the season is 60.66°, or 11.72 above that of Spring. The **Medium** of the twenty-four hours rises during the season from 58° to 65°; but returns before the close, to the former level.

The mean height of the **Barometer** for Summer is 29.877 in.; or .045 in. above the Vernal mean. The atmosphere now acquires, under the more vertical rays of the Sun in Full North declination, the greatest quantity of heat and vapour which it at any time contains; and it accordingly weighs most by the Barometer. The range of this instrument still diminishes to the middle of the season, when it does not exceed an inch: it then gradually increases again to the end: the mean range 1.08 in.

I have shown that the great fluctuations in the density or gravity of the atmosphere, in our climate, are principally due to our participation, by turns, of the Polar and Tropical atmospheres; between which we are situate. But our position in Summer, when by the inclination of our pole towards the Sun we are presented in a more direct manner to the rays, approximates the habits of our climate to those of the Equatorial regions; and we thus become more uniform, both in temperature and density, than at any other season;- though still greatly more variable, in both respects, than the countries in that part of the globe. In proportion as the Sun rises higher, and continues longer above the horizon, the Moon, to whose influence I have attributed the variable winds of our climate, become depressed, as to our latitudes. Her influence, consequently, is diminished, and that of the Sun, to which we have seen ascribed more uniform action on the winds, is established in its place. Such appear to be the reasons, why the Barometer varies so much less in Summer than in winter: but its movements in ascent or descent in this season, are not therefore the less indicative of those changes in the density of the air, on which the weather, in some considerable degree, depends.

An important part of the Agricultural business of our district, **the making of hay**, is chiefly conducted within the limits of this season. I have no doubt, that this branch of Rural economy has derived very considerable aid from the use of the Barometer — and in fact, that much less of valuable fodder is spoiled by wet, now, than in the days of our forefathers. But there is yet room for improvement in the knowledge of our farmers, on the subject of the atmosphere. It must be a subject of great satisfaction and confidence to the husbandman, to know at the beginning of a Summer, by the certain evidence of Meteorological results on record, that the season, in the ordinary course of things, may be expected to be a dry and warm one: or to find, in a certain period of it, that the average quantity of rain to be expected for the month has already fallen. On the other hand, when there is reason, from the same source of information, to expect much rain, the man who has courage to begin his operations under an unfavourable sky, but with good ground to conclude, from the state of his instruments and his collateral knowledge, that a fair interval is approaching, may often be profiting by his observations; while his cautious neighbour, who waited "for the weather to settle," may find that he has let the opportunity go by. This superiority, however, is attainable by a very moderate share of application to the subject; and by the keeping of a plain diary of the Barometer, and Rain-gauge, with the Hygrometer and the Vane under his daily notice.

The predominating **Winds** of our Summer are clearly the W-N, or those which range from the West to North, the latter point not included.

The Mean **Evaporation** is 11.580 inches, being above a fourth part more than the proportion indicated by the Temperature. De Luc's **Hygrometer** averages 52 degrees through the season.

The mean Rain is 6.682 [by the long average 6.64] inches. I have treated at some length, under the head Rain, of the proportions of Rain in the different seasons; and shown the reason why, if we divide the year into two moities by the Solstices, we have very unequal proportions of rain with nearly equal Mean temperatures; if by the Equinoxes, then very unequal temperatures for the two halves, with nearly equal proportions of rain. I have likewise, in that part of the work, endeavoured to show the connexion of our rain with the prevailing winds; and the different quarters from which we may more immediately derive the Vapour, which forms rain in the different seasons.

Referring to the diagram, p.70[h.], and the several divisions immediately following it, I may here shortly state, that our Summer rains, (which are much the most plentiful in the middle of the season, or during the Seventh Month,) appear to be the result of a less powerful and constant operation of the causes which produce the **Tropical** rains. Hence our wettest summers are those in which, by the concurring effects of the Sun's declination and the currents, we partake the most of the Tropical atmosphere: and we obtain a dry Summer only by approximating, in consequence of an opposite course of winds or an atmosphere generally calm or breezy, to the circumstances of the high Northern latitudes. In the one case, we seem to be placed in the great general stream of subsiding air

[h.] Which the reader will compare with that in p.85.

from the South; in the other, in the air returning from the North, after having deposited its excess of water. A North-west current is therefore our fair-weather wind; which will bring us moderate weather and sunshine, so long as it is not interfered with by Southerly currents, and these I have shown to arrive, when they bring us rain and thunder, for the most part with an Easterly direction: consequently in a way the most likely to mix with, and be decomposed by, the prevailing Westerly current.

When there exists a tendency to this process, our Summer clouds, in consequence of the greater quantity and more elevated situation of the vapour, exhibit a magnificence approaching to that of the Tropical sky. The **Cirrus**, which is usually the first to make its appearance after serene hot weather, now spreads its tufts to a greater extent, and assumes a more dense appearance than in spring; and the **Cumulus**, ever beautiful and of favourable aspect when insulated in the midst of sunshine, now tends constantly to inosculate above, or to become grouped laterally, with the **Cirrocumulus** and **Cirrostratus** which occupy the middle region. From the mixture of these, and the interspersion of a quantity of anomalous haze, in patches or extensive beds, there results a sky more readily remembered than described, which is very easily and suddenly resolved into Thunder-showers. The locality of these is often determined by the place of a rapidly growing **Cumulus**, which becoming a centre of union for the surrounding looser portions, gradually extends itself above and around, till it has put on the form of **Cumulostratus**; the last stage before the explosion which decides the precipitation of the water in heavy rain. This once begun, the **Nimbus**, with a confused moving and spreading sheet, increasing the obscurity on all sides, renders further observation from below very imperfect. At every interval, however, of some hours duration, with the same winds, the same state of the sky returns again. A tendency to **rain** in such a sky, is perhaps as decidedly indicated, by the grouping of the **Cirrus** and haze in certain parts, in the form of the crown of a **Nimbus**, as by any other symptom; while the **Cirrocumulus**, which is the proper natural index of a rising temperature, is favourable to dryness; except as it forms a part of the preparatory machinery of Thunder-storms. In the latter case it is usually arranged on a kind of arched base, mixed with the Cirrus and Cirrostratus, and the whole with the haze above mentioned. The immediate tendency to an Electrical explosion is always indicated to those who have the view of the lower part of the cloud, by a surprisingly quick motion of the loose ragged portions of **scud** around it; which seem in haste to obey the powerful attraction of the mass, and take their places in the general arrangement, on which probably the effect depends. A Thunder-storm in profile on the horizon, in the dusk of the evening, is one of the most sublime spectacles in nature. Such is the immense depth and extent, and the picturesque forms and complex arrangements of these natural batteries, before the explosions:- and when these have commenced, it is easy, for a while, to discover the very cloud from which each proceeds, the whole substance of it becoming, at the moment, incandescent with electric light. In proportion as the charge is drawn off, the high-wrought forms of the clouds disappear, the crowns of Nimbi are spread out above, and the whole passes into the more familiar appearance of a distant bank of showers; which in effect it now constitutes.

AUTUMN begins the 8th of the Ninth month, **September**, and occupies 90 days. The Mean **temperature** is 49.37° — or 11.29° below the Summer: the medium of the day declines in this season from 58° to 40°.

The mean height of the **Barometer** is 29.781 inches; being .096 in. below the mean of Summer. The range increases rapidly during this season; the mean extent of it is 1.49 inches.

The prevailing **Winds** are the class S-W, throughout the season.

The **Evaporation** is 6.444 inches, or a sixth part less than the proportion indicated by the Temperature. The mean of De Luc's **Hygrometer** is 72 degrees.

The Mean Rain is 7.441 [by the long average 7.49] inches: the proportion of rain increases, from the beginning to near the end of the season. This is the true rainy season with us; and the earth, which had become dry to a considerable depth during the Spring and Summer, now receives again the moisture required for springs and for the more deeply rooted plants, in the following year.

The changes in the state of the atmosphere in Autumn are all referable to one and the same cause — the return of the Sun to the South. The heat declining daily, the store of vapour in the atmosphere undergoes a continued decomposition; the loss of weight arising from which is not made up, as in Summer, by an equal production of new vapour. Hence a declining Barometer, with extensive heavy rains, chiefly in the latter part of the season. The whole increase, derived on the average of the Barometer in Spring and Summer, is thus disposed of, and the atmosphere returns to its minimum weight. From the more saturated state of the air, the Evaporation falls short of the Temperature; and the **Hygrometer**, at the same mean temperature, exhibits an average 11 degrees more moist than that of Spring.

The fore part of this season is, nevertheless, if we regard only the sky, the most delightful part of the year, in our climate. When the decomposition of vapour, from the decline of the heat, is as yet but in commencement — or while the Electricity remaining in the air, continues to give buoyancy to the suspended particles, a delicious calm often prevails for many days in succession, amidst a perfect sunshine, mellowed by the vaporous air, and diffusing a rich golden tint as the day declines upon the landscape.

At this period, chiefly, the **Stratus** cloud, the lowest and most singular of the Modifications, comes forth in the evenings, to occupy the low plains and valleys, and shroud the landscape in a veil of mist until revisited by the Sun. So perfectly does this inundation of suspended aqueous particles imitate real water, when viewed in the distance at break of day, that I have known the country people themselves deceived by its unexpected appearance.

A phenomenon attends this state of the air, too remarkable to be passed over in silence, though it belongs in strictness to another branch of Natural history. An immense swarm of small **Spiders** take advantage of the moisture, to carry on their operations; in which they are so industrious, that the whole country is soon covered with the fruit of their labours, in the form of a fine network; the presence of which I have at different times noticed in my Journal, under the term **Gossamer**. They appear exceedingly active in pursuit of small insects, which the cold of the night now brings down; and commence this fishery about the time that the swallows give it up, and quit our shores. Their manner of loco-motion is curious: half volant, half aeronaut, the little creature darts from the papillæ on his rump a number of fine threads which float in the air. Mounted thus in the breeze, he glides off with a quick motion of the legs; which seem to serve the purpose of wings for moving in any particular direction. As these spiders rise to a considerable height, in very fine weather their tangled webs may be seen descending from the air in quick succession, like small flakes of cotton.

On threads of stronger texture, produced by some of these autumnal spiders, and which I have found often extended from tree to tree for some yards in length, the most minute dew-drops collect in close arrangement, and on the first touch of the support, run together and fall down; giving thus a practical illustration of the manner of the formation of rain in the atmosphere. And both on these, and on webs placed in an oblique or vertical direction, on the shrubs and herbage, and formed with the symmetry usually displayed by this insect, these drops are occasionally found frozen: and a string of little ice beads may be taken up from the web. From the texture thus covered with dew, the solar rays at times reflect innumerable little **Irides**, which will not be overlooked by those who know how to appreciate the smaller beauties of an autumnal landscape.

Nor should the heavy **dews** of this season pass unmentioned: which I have sometimes found so abundant, as to be capable of daily measurement in the rain-gauge. See the Notes under Tables XXIV and XXXVII.

In the drops of dew, when of considerable size, under the clear morning Sun, the Meteorologist may find a good instance of the reflection and refraction which produce the Rainbow. He has only to place himself with his back to the Sun, and singling out a particular drop which appears brilliant with any colour, he may, by changing his position so as to vary the angle, and keeping his eye on the drop, draw out the different prismatic tints in succession.

The latter part of this season, and the beginning of Winter, are more peculiarly subject to gales of wind from the South-west. While our North-east breezes are plainly the result of sunshine, and blow almost exclusively by day, **these** appear to prevail chiefly by night: the one forming part of an ascending, the other of a subsiding set of currents. That our Westerly gales come from above, is manifest from the manner in which the clouds indicate, before-hand, the increase and decrease of velocity which they afterwards manifest below. And there seems no way of accounting for their occasional excessive force, but by attributing it to the Westerly **momentum**, which the air acquires in a higher latitude, by revolving in a larger circle about the Earth's axis, and which it may bring with it when suddenly translated North-ward. It is even worthy of consideration, whether the sudden depressions of the Barometer, of a few hours' duration only, which accompany these gales, and exhibit their minimum point about the time of the greatest force of the wind, are not to be attributed **to an actual loss of gravity, by the centrifugal free in the air, for the time**.

However much we may be exposed, at seasons, to these boisterous visitants, the tremendous concussion of the elements, properly denominated a **Hurricane**, is almost unknown in our climate. Yet we may not conclude it absolutely exempt from real hurricanes. The force of the wind is occasionally such for a short time, as to give it the characteristic qualities of this phenomenon — uprooting and breaking timber-trees, damaging solid buildings, and rolling up or removing the heavy sheets of lead with which they are covered. See Tables XXVIII, XXXIX, LXXVII, CI.

To produce, however, one of the most memorable instances on record, I shall make some extracts from an old publication, having the following title. "The Storm, or a collection of the most remarkable Casualities and Distresses which happened in the late dreadful Tempest both by Sea and Land. London, 1704," 12mo. pp.272. The motto, "The Lord hath his way in the whirlwind, and in the storm, and the clouds are the dust of his feet. Nah. i. 3."

The date of this tempest, as to its extreme violence, is the night of the 26-27 November, O.S. 1703, being about the time of New Moon. It appears to have been preceded by a very wet season for about six months.

"It had blown exceeding hard (says the anonymous compiler, who seems to have been a man of respectable rank, and careful to have authorities for his facts) for about fourteen days past, that we thought it terrible weather: several stacks of chimnies were blown down, and several ships lost, and the tiles in many places blown off the houses; and the nearer it came to the fatal 26th of November, the tempestuousness of the weather increased.

"On the Wednesday morning before, being the 24th of November, it was fair weather and blew hard: but not so as to give any apprehensions, till about four o'clock in the afternoon the wind increased, and with squalls of rain and terrible gusts blew very furiously. The wind continued with unusual violence all the next day and night; and had not the **Great Storm** followed so soon, this had passed for a great wind.

"On Friday morning it continued to blow exceeding hard, but not so as that it gave any apprehensions of danger without doors. Towards night it encreased; and about 10 o'clock our Barometers informed us that the night would be very tempestuous — **the mercury sunk lower than ever I had observed it on any occasion**. It did not blow so hard till twelve at night, but that most families went to bed: but about one, or at least by two o'clock, 'tis supposed, few people that were capable of any sense of danger, were so hardy as to lie in bed. And the fury of the tempest increased to such a degree, that as the Editor of this account, being in London and conversing with the people the next day, understood, most people expected the fall of their houses. And yet, in this general apprehension, nobody durst quit their tottering habitations; for whatever the danger was within doors, 'twas worse without. The bricks, tiles, and stones, from the tops of the houses, flew with such force, and so thick in the streets, that no one thought fit to venture out, though their houses were near demolished within.

"It is the received opinion of abundance of people, that they felt, during the impetuous fury of the wind, several movements of the earth; and we have several letters which affirm it: but as an earthquake must have been so general, that every body must have discerned it; and as the people were in their houses when they imagined they felt it, the shaking of which might impose upon their judgment, I shall not venture to affirm it was so. Others thought they heard it thunder. 'Tis confessed the wind by its unusual violence made such a noise in the air, as had a resemblance to thunder;- the roaring had a voice as much louder than usual, as the fury of the wind was greater than was ever known: the noise had also something in it more formidable: it sounded aloft, and roared not very much unlike remote thunder. And yet, though I cannot remember to have heard it thunder, or heard of any that did, in or near London, in the countries, the air was seen **full of meteors and vaporous fires**; and in some places both thunderings and universal flashes of lightning, to the great terror of the inhabitants.

"From two of the clock the storm continued, and increased till five in the morning; and from five to half an hour after six, it blew with the greatest violence. The fury of it was so exceeding great for that particular hour and a half, that if it had not abated as it did, nothing could have stood its violence much longer. In this last part of the time, the greatest part of the damage was done. Several ships, that rode it out till now, gave up all — for no anchor could hold. Even the ships in the Thames were all blown away from their moorings, and from Execution-dock to Limehouse-hole there were but four ships that rode it out: the rest were all driven down into the **Bight**, as the sailors call it, from Bell wharf to Limehouse, where they were huddled together and drove on shore, heads and sterns one upon another, in such a manner as any one would have thought it had been impossible.

"The points from which the wind blew are variously reported from various hands. 'Tis certain, it blew all the day before at SW, and I thought it continued so till about two o'clock; when as near as I could judge by the impressions it made on the house — for we durst not look out — it veer'd to the SSW, then to the W; and about six o'clock to W by N — and still the more Northward it shifted the harder it blew till it shifted again Southerly about seven o'clock; and as it did so it gradually abated.

"Though the storm abated with the rising of the Sun, it still blew exceeding hard; so hard that no boats durst stir out upon the river, but upon extraordinary occasions; and about three o'clock, the next day, it encreased again, and we were in a fresh consternation.- At four it blew an extreme storm with sudden gusts as violent as at any time of the night; but as it came with a great black cloud and some thunder, it brought a hasty shower of rain which allayed the storm, so that in a quarter of an hour it went off, and only continued blowing as before.

"This sort of weather held all Sabbath-day, and Monday, till on Tuesday afternoon it encreased again, and all night blew with such fury that many families were afraid to go to bed.- At this rate it held blowing till Wednesday about one o'clock in the afternoon which was that day sevennight on which it began — so that it might be called one continued storm from Wednesday noon to Wednesday noon. **In all which time there was not one interval in which a sailor would not have acknowledged it blew a storm**; and in that time two each terrible nights as I have described."

Such a tempest could not be supposed to be limited to this island — accordingly it appears to have spread over a great part of the North of Europe, though no where with equal impetuosity as with us. As to the effects, they were generally these: Over most part of South Britain and Wales, the tallest and stoutest timber-trees were uprooted, or snapt off in the middle. It. was computed that there were twenty-five parks in the several counties, which lost a thousand trees apiece — the New Forest, Hants, above four thousand. Whole sheets of lead were blown away from the roofs of strong buildings; seven steeples, above four hundred windmills, and eight hundred dwelling houses, blown down; and barns, out-houses, and ricks in proportion; besides a great destruction of orchards. About one hundred and twenty persons lost their lives, on land; among whom were the Bishop of Bath and Wells and his lady, who unhappily lodged in a ruinous castle: also the engineer who had erected the then lighthouse at the Eddystone; who was blown into the sea along with the structure, which he had promised himself would bid defiance to the elements.

At sea there were few ships to sink — the previous terrible weather having brought them into port in very unusual numbers — but in the harbours and roadsteads of England, so many vessels ran foul of each other and sunk, or foundered at anchor, or were driven on the sands, or to sea where they were never heard of, that it is computed eight thousand seamen at least perished on the occasion. A vessel laden with tin, being left in the small port of Helford near Falmouth, with only a man and two boys on board, drove from her four anchors at midnight: and going to sea, made such speed before the wind, almost without a sail, that at eight in the morning, by the presence of mind of one of the boys, she was put into a narrow creek in the Isle of Wight, and the crew and cargo saved.

This run may give us some conception of the velocity of the wind: for if we consider that the course of the vessel, even by the winds, could not have been direct, but in a large curve outwards from the coast, the rate at which she went exceeded thirty miles an hour on the average: and that of the wind must have been three or four times greater.

The estuary of the Severn, lying more particularly in the course of this storm, the parts bordering on that river suffered much by the breaking in of the sea. The country for a great extent was inundated, the vessels driven upon the pasture land, and many thousands of sheep and cattle drowned.

To conclude this description, the spray of the sea was on this occasion carried far inland in such quantities, as to form little concretions or **knobs** of salt on the hedges; and at twenty-five miles from the sea, in Kent, made the pasture so salt, that the cattle for some time would not eat it. The total damage was considered, by the Editor of the work I have been quoting, to exceed that of the great fire of London.

OF THE MONTHS.

First Month. January.

The Sun in the middle of this Month continues about $8^{h.}20^{m.}$ above the horizon.

- The **Temperature** rises in the day, on an average of twenty years, to 40.28°; and falls in the night, in the open country, to 31.36° — the difference 8.92°, representing the mean effect of the Sun's rays for the month, may be termed the Solar variation of the Temperature. The mean temperature of the month, if the observations in the city be included, is 36.34°[i]. But this mean has a range, in ten years, of about 10.25°, which may be termed the Lunar variation of the Temperature. It holds equally in the decade, beginning with 1797, observed in London, and in that beginning with 1807, in the country. In the former decade, the month was coldest in 1802, and warmest in 1804: in the latter, it was warmest in 1812, and coldest in 1814.[*] I have likewise shown in Figures 7&8 on p.24, that there was a tendency in the daily variation of temperature through this month, to proceed in these respective periods of years, in opposite directions. The prevalence of different classes of winds, in the different periods, is the most obvious cause of these periodical variations of the Mean temperature.
- The **Barometer** in this month rises, on an average of ten years, to 30.40 in. and falls to 28.97 in.: the mean range is therefore 1.43 in.; but the extreme range in ten years is 2.38 in. The mean height for the month is about 29.79 inches[k].
- The prevailing **Winds** are the class from West to North. The Northerly predominate, by a fourth of their amount, over the Southerly winds.
- The average **Evaporation** (on a total of 30.50 inches for the year) is 0.832 in., and the mean of De Luc's **Hygrometer** 80.
- The mean **Rain**, at the surface of the Earth, is 1.959 in.; and the number of days on which snow or rain falls, in this month, 14.4.[l]
- A majority of the **nights** in this month have constantly their temperature at or below the freezing point.

Second Month. February.

Length of day in the middle of the month about $9^{h.}55^{m.}$.

- Mean of greatest heat by **day** 44.63°, of greatest cold by **night** 33.70°: difference, or **Solar variation** 10.93°.
- **Mean temperature** of the month, the city temperature included, 39.60°: difference in the mean, or **Lunar variation**, from 1797 to 1806, in London, 7.45°; from 1807 to 1816, in the country, 11.75°. The month was coldest in 1800 and 1814, and warmest in 1806 and 1809.

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[i] The Mean Temperature of the respective Months, and their Mean of greatest heat by day and cold by night, for the Sepenary ending with 1823, are given in p.33.

[*] As the Temperature of the Month in other years approaches near to either extreme, the reader will do well to consult Table A, from whence these results are taken, as he proceeds.

[k] The Monthly Mean range and Extremes of the Barometer, for seventeen years from 1815 to 1831, are stated, with a pair of Curves, at p.45.

[l] The Monthly Averages of Rain are extended to a period of thirty-four years at p.85.

- The **Barometer** ranges, on a mean, from 30.42 to 29.07 in.: difference 1.35 in.: but the fall range in ten years extends to 2.01 inches. Mean height for the month 29.874 in.
- The prevailing **Winds** are the class from South to West.
- The proportionate **Evaporation** is 1.647 in.: and the mean of De Luc's **Hygrometer** 75 degrees.
- The average **Rain** at the surface is 1.482 in.: and the average number of days on which any falls, 15.8. This is the month in which, on the whole, rain or snow falls the oftenest. The frosty nights vary from three to twenty-two, and the average of these on ten years is **eleven**.

Third Month. March.

The middle day has the Sun for about $11^{h.}50^{m.}$.

- The mean heat rises by **day** to 48.08°, and falls by **night** to 35.31°; the **Solar variation** is therefore 12.77°.
- The **Mean temperature** of the month is 42.01°, the London observations included. The **Lunar variation**, in the first decade, was 6.74°; in the second 11.08°. The month the coldest in 1799 and 1807, and warmest in 1801 and 1815.
- The mean range of the **Barometer** in this month is from 30.40 to 29.10, or 1.30 in.; the full range for 10 years being 1.80 in. Mean height for the month 29.87 inches.
- The prevailing **Winds** are decidedly the class from North to East: and these sensibly impede the advance of the Temperature.[m]
- The proportionate Evaporation is 2.234 in.: and the mean of De Luc's hygrometer 67 degrees.
- The average Rain at the surface is 1.299 in.: and it rains on a mean, in this month, only on 12.7 days.
- There are, on an average, twelve frosty nights in this month; the proportion varies from five to twenty-three.

Fourth Month. April.

The Sun is above the horizon, in the middle of the month, about $13^{h.}57^{m.}$.

- The Temperature rises by **day** to 55.37°, and falls by **night** to 39.42°: the **Solar variation** is consequently 15.95°.
- The **Mean temperature** of the month for London and the country, is 47.61°. It varied in the first decade 7.54, in the second 8.64°: the **Lunar variation** is therefore probably pretty uniform. The month was warmest in 1798 and 1811, and coldest in 1798 and 1808.
- The **Barometer** ranges, on an average, from 30.23 to 29.15 inches: the mean range is therefore 1.08, but the full range in ten years is 1.62 inches. Mean height for the month 29.814 inches.
- The prevailing **Winds** are still from North to East: yet the advance of the Temperature is now somewhat quicker.
- The proportionate **Evaporation** is 2.726 in.: being little more than in last month: the mean of De Luc's **Hygrometer** is however 60.
- The mean amount of **Rain** at the surface is 1.692 in.: and it falls on an average on 14 days of this month.
- During ten years, this month never passed quite without a frosty night or morning, and it has six of these on an average.

Fifth Month. May.

The length of the middle day is about $15^{h.}35^{m.}$.

- The heat rises, on a mean, in the **day** to 64.06°, and falls in the **night** to 46.54°. **Solar variation** 17.52°.

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[m] This is on the Decade; the Reader may compare with it the different state of the winds in spring in the Septenary, by turning to the Tables in p.50 and p.52.

- The **Mean temperature** of the month, with the city included, is 55.40°: the **Lunar variation** in the first decade was 7.44°; in the second 10.54°. The month was warmest in 1804 and 1811, and coldest in 1802 and 1816.
- The **Barometer** rises, on a mean, to 30.25, and falls to 29.34, mean range 0.91 in.: but the full range in ten years is 1.52 inch. Mean height for the month 29.812 inches.
- The prevailing **Winds** are the class from South to West: by means of which, in aid of the sun, we get an advance in this month, upon the last, of near eight degrees, and acquire some heat against the coming of summer.
- The proportionate **Evaporation** is now 3.896 in.: and the mean of De Luc's **Hygrometer** 57 degrees.
- The average **Rain** at the surface is 1.822 in.: and rain falls on 15.8 days of this month.
- In five seasons out of ten, the nocturnal Temperature, or that a little before sun-rise, touches in this month once or twice upon the freezing point.

Sixth Month. June.

The length of day, in the middle of this month, extends to about $16^{h.}32^{m.}$.

- The mean heat rises in the **day** to 68.36°, and falls in the **night** only to 49.75°: the **Solar variation** is then 18.61°, which is the largest for the year; consistently with the Sun's greatest altitude on the 21st of this month.
- The **Mean temperature** of the month, with London included, is 59.36°. It varies in the ten years from 1797 to 1806, 6.44°, and in the following decade 5.80°. The **Lunar variation** is therefore pretty uniform, and on the whole at its minimum for the year. The month was warmest in 1798 and 1811; and coldest in 1797 and 1812.
- The **Barometer** rises, on a mean, to 30.28, and falls to 29.45; the difference 0.83 in.: but the full variation in this month, for ten years, is 1.25 inches: the mean height for the month about 29.90 inches.
- The prevailing **Winds** are the class from West to North.
- The proportionate **Evaporation** is 3.507 inches, being less than that of last month, the advance of the temperature notwithstanding. The mean of De Luc's **Hygrometer** 52 degrees.
- The mean amount of **Rain** is 1.920 in.: the average number of days on which any falls is 11.8 only, being the lowest of any month in the year.
- I meet with no instance, in the course of ten years, of a frosty night or morning in this month.

Seventh Month. July.

Length of the middle day about $16^{h.}5^{m.}$.

- Mean highest temperature by **day** 71.50°; mean lowest by **night** 53.84°. **Solar variation** 17.66°.
- **Mean temperature** of the month, for London and the country, 62.97°. The **Lunar variation** is nearly uniform, being 7.14° for the decade of observations in London, and 8.40° for that in the country. The month was hottest in 1803 and 1808, and coldest in 1802 and 1812.
- The **Barometer** rises, on the average, no higher than 30.18, and sinks only to 29.49 inches: the mean range is therefore 0.69 in.: and the full range being only 0.99 in. it has in this month the smallest variation in the year. Mean height about 29.88 inches.
- Notwithstanding this state of the Barometer, the class W-N continues to include the **Winds** most prevalent in this month: and these, with their antagonists from the South, occasionally blow with considerable force at this season. See the Notes under Table CXXI.
- The proportionate **Evaporation** is 4.111 inches; and the mean of De Luc's **Hygrometer** again 52 degrees.
- The average **Rain** of the month is 2.637 inches: and rain falls, on a mean, on 16 days of this month.

Eighth Month. August.

On the middle day of this month we have the Sun for about 14h.32m..

- The heat rises by **day**, on a mean, to 71.23°, and sinks by **night** only to 53.94°: we have now the warmest nights in the year, and but little abatement of the temperature by day. The **Solar variation** therefore keeps up to 17.29°; which is a degree and one-third more than in the corresponding month in spring, the fourth. But we are to recollect that, at the present season of the year, the action of the Sun's rays is considerably assisted by the warm earth, which radiates heat into the air: while in spring it absorbs every day a proportion of the heat which the Sun produces.
- The **mean heat** of the month, with London included, is 62.90°.
- The **Lunar variation** is very uniform, being 7.07° in the first decade, and 7.44° in the second. The month was hottest in 1802 and 1807, and coolest in 1799 and 1812.
- The **Barometer** rises on a mean in this month to 30.19, and sinks to 29.43 in.; the mean range is consequently 0.76 in.: the full range for 10 years is 1.02 in. Mean height for the month 29.854 in.
- The **Winds** from West to North prevail most in this month also.
- The proportion of **Evaporation** is 3.962 inches, and De Luc's **Hygrometer** continues to average 52 degrees.
- The average **Rain** of the month is 2.125 inches; and it falls, on a mean, in this month, on 16.3 days. The rain in this, and the two preceding summer months, presents a very uniform average, (when corrected for the different elevation of the gauges,) on the two decades of years.

Ninth Month. September.

The middle day is about 12h.39m. from sun-rise to sun-set.

- The heat, on a mean, **rises** to 65.66°, and **falls** to 48.67°; making a **Solar variation** of 16.99°. This is but a fraction of a degree less than that of last month, and 4.22° more than in the month. From the different place of the Equinox in each, the Third is astronomically colder than the Ninth month; but we have besides, and in a greater degree, a source of inequality in their temperature, in the absorption and radiation of heat by the earth, already treated of.
- The **Mean temperature** of this month is, for London and the country together, 57.70°. The **Lunar variation** is nearly uniform, being 6.61° for the first decade, and 5.98° for the second. The month was coldest in 1803 and 1807, and warmest in 1804 and 1810.
- The mean of ten maxima of the **Barometer** for this month is 30.23 in.: of ten minima 29.33 in.: giving a mean range of 0.90 in.: but the full range on ten years is 1.54 in.: mean for the month 29.833 in. — the greater oscillations beginning now to come on again, in proportion as the temperature declines, and the currents get more interchange of direction, Northward and Southward.
- The prevailing **Winds** of this month are, on the whole, the class S-W.
- The mean proportionate **Evaporation** is 3.068 inches, and the mean of De Luc's **Hygrometer** 64 degrees.
- The average **Rain** for the month is 1.921 in.: and the number of days on which any falls, only 12.3: so that, on the ten years from 1807, it is the month which stands next, in point of dryness to the sixth; the Third being, however, nearly equal to it. It is proper to remark, that on the decade from 1807 to 1816, the average rain for this month is about half an inch **less** than on the former decade; while for the Third month, it is about as much **more**. The translation of a portion of rain from the autumnal to the vernal equinox obtained, therefore, in a greater degree in the latter, than in the former period.
- In this month we have occasionally a frosty night or two. In 1816, it froze pretty sharply on the 2d: in 1815, on the 6th and 7th; and in 1807, by placing a Thermometer near the ground, I detected a Temperature of 26°, on the 13th of the month.

Tenth Month. October.

The middle day of this month has the Sun for about 10h.37m..

- The mean of the greatest heat by **day** is 57.06°, of greatest cold by **night** 43.51°: the **Solar variation** 13.55°.
- The **Mean Temperature**, for the city and country, is 50.79°: the **Lunar variation** of which is smaller, in the decade for the city, than in any other instance in these observations, being only 4.51°: but in the country decade it amounts to 9.18°. I am not prepared to suggest any peculiar cause for this very small variation in one decade, while a mean one obtains in the other; but we shall see a more remarkable instance of this in the Twelfth month. The Tenth month was coldest in 1797 and 1814, and warmest in 1804 and 1811.
- The **Barometer** in this month rises, on a mean to 30.21 and sinks to 29.05 in.: mean range 1.16, full range 1.72 in: mean height for the month 29.736 in.
- The **Winds** from South to West predominate.
- The proportionate **Evaporation** is 2.208 in.: and De Luc's **Hygrometer** averages now 71 degrees.
- The average **Rain** is 2.522 inches: it rains, on a mean, on 16.2 days of the month. The month being somewhat wetter in the decade beginning with 1807, than it had been in the preceding ten years.
- The Tenth month is less subject to frost, than we might expect from the advanced period of the year. It has not usually above **four** nights, and sometimes none at all, with the Thermometer below the freezing point: the warmth of the ground is one obvious cause.

Eleventh Month. November.

The middle day of the month extends only to 8h.49m..

- The average temperature, however, **rises** to 47.22°, and **sinks** only to 36.49°, making a **Solar variation** of 10.73°; while in the First month, with a mean day of 8h.20m. it was but 8.92°. It may be necessary, both in this month and the last, to admit as an additional cause of the comparative warmth, the heat given out by the great quantity of aqueous vapour now condensed into Rain: while in Spring, the temperature may be proportionately kept down by the effect of Evaporation, in which process much of the atmospheric warmth occasionally disappears.
- The **mean Temperature** for the whole district is 42.40°. It varies 7.52° in the decade beginning with 1797, and 8.14° in that beginning with 1807; the **Lunar variation** is therefore nearly uniform. The month was coldest in 1798 and 1816, and warmest in 1806 and 1811.
- The **Barometer**, which constantly enlarged its movements in receding from the Summer season, now exhibits the greatest **depressions**. It rises, on a mean to 30.36, and sinks to 28.60 inches, making the range in this way 1.46 in.: but the full range in ten years is 2.12 inches. Mean height for the month 29.725 inches.
- Consistently with this state of the **Barometer** we have now the South-west winds oftenest — but with a large mixture at intervals of Northerly; which average considerably above their mean. Perhaps the greatest interchange of these currents now takes place in our atmosphere.
- The proportionate **Evaporation** is now reduced to 1.168 in.; and the mean of De Luc's **Hygrometer** advanced to 80 degrees.
- The mean **Rain** of this month is 2.998 inches: it is consequently the wettest month in the year: and it is observable, that it was somewhat drier in the decade beginning with 1807, than in the preceding ten years. Rain falls on precisely half the number of days in the month.
- In this, and the preceding month, but most in the present, the depressions of temperature occur, which bring on the cold of Winter in our climate. It will be seen that we lose about eight degrees on the mean. A gloomy windy sky is accordingly the prevailing characteristic of the season; but this is not constant; and we have at intervals also in this month, very fine days, with clear nights and hoar-frosts.

- ❖ With regard to **frosts**, this month has eleven or twelve nights, on an average, on which the Thermometer is at or below 32°; and the following **gradation** appears in the number of such nights in the month, from 1811 to 1816 inclusive, *viz*. 5, 9, 12, 14, 17, 20; shewing the progressively increasing tendency to a low temperature, as this series of years proceeded.

Twelfth Month. December.

Our day is reduced, in the middle of this month, to about 7h.46m..

- ❖ The average Temperature **rises** to 42.66° and **sinks** to 33.90°. The **Solar variation** is therefore only 8.76°, being the smallest for the year; consistently with the Sun's place in declination.
- ❖ The **Mean temperature**, with London included, is 38.71°. It varied in the decade from 1797 to 1806, to the extent of 14.45°; and in that from 1807 to 1816, only 5.45°. The **Lunar variation** is therefore now the most extensive, and the least uniform. The mean of this month in 1799, in London, was 34.30°: the month had become nearly as cold in the preceding year, having then sunk in its mean about 7½ degrees. In 1806 it was, by the London observations, 48.75°, and by my own at Plaistow 46.27°. It had increased in the preceding year; and a similar gradation from cold to warmth in this month took place in the years 1801-2-3, when it was carried in the last, to 42.78°. In the latter decade, on the contrary, the gradation twice proceeds, through four years, towards the lower extreme.
- ❖ By returning to Tables I and II the reader will see the **immediate** cause of the hibernal warmth, in the great prevalence of Southerly winds, more especially the SW. By these, the temperature of the fore part of the winter was kept up nearly to the pitch of spring: and the notes present some instances of the effects which this had on vegetation. A decided flow of air from the Southward, without almost the intervention of a frosty night, must be expected to produce a very different mean, from a season in which most of the nights are frosty. And the difference from this cause may be expected to be greatest, when we have the least of the Sun's influence: but the question, **what it is that determines this Southerly current to our district**, in one year or series of years more than another, remains to be solved.
- ❖ The **Barometer** rises, on a mean to 30.40, and sinks to 28.95 inches, giving a mean range of 1.45 in.; the extreme range being 2.37 inches, nearly as large as in the First month, which: the greatest for the year. The mean height of the **Barometer**, is 29.745 inches.
- ❖ The Westerly **winds**, on the whole, preponderate. The proportionate **Evaporation** is 1.12 in.: and De Luc's **Hygrometer** continues to exhibit its winter mean of 80 degrees.
- ❖ The average **Rain** is 2.437 inches. Rain or snow falls on 17.7 days of the month; which is therefore, nearly, the most subject to what is sometimes provincially termed "falling weather."
- ❖ On an average of ten years, about half the nights in this month appear to be frosty.

A few things remain to be noticed, which have been overlooked in their proper places, and which may suitably occupy the remainder of this sheet.

1. Where the Notations of the Wind appear in italics, in the column allotted to them in the Tables of the Second volume, it may in general be inferred, that the remainder of the observations for the days were borrowed, together with these, from the Royal Society's, or some other Register, in order to perfect my averages.*

2. I have given, in p.37 of this Volume, the reasons which induced me to insert, on many occasions, the Notations by a **Second Thermometer**, along with those from which I took my Mean and Extreme Results. I consider these, together with those of a Second Barometer and Rain-gauge, as affording a general confirmation of the Results, while they shew particular differences, or even discrepancies, in the observations.

* In this edition, these italics have not been maintained.

3. The terms which I proposed, in 1804, for the **Modifications of Clouds**, were at first sparingly employed in my observations: I waited to see if the public would sanction them — and I wish not, at any time, to see Registers crowded with these observations beyond their proper use for completing the history of the phenomena of the season.

4. The Reader is requested to compare, for himself, by the help of the Index, the very many cases of storms, inland or on the coast, concurring with the **depressions of the Barometer**, recorded in these Volumes: and on which it would have taken an unreasonable space to dwell particularly. The observations by the **Clock**, which show these depressions most perfectly, begin at Tab. CII in the Second Vol.: in 1815. The like observation applies to the agreement of the heavier amounts of **Rain** with the previous indications.

5. He may likewise search the papers and other records (if inclined to forward useful enquiries of the sort) for accidents by **explosion in Coal mines**, coinciding with a depressed state of the Barometer — of which it is believed there would be found many. The Extracts from the papers, inserted in my volumes, are not to be regarded as a collection of such things. I took them as they came in my way, in the course of reading books, or turning over the file of the News: using, of course, some discrimination, and selecting what might illustrate my own matter.

6. The appearances consequent on **a stroke of Lightning**, related in the Note, under Tab. XXXIV, seem to indicate an effect of the Electrical energies, which deserves to be more attentively examined. The fluid appears to have the faculty, during its passage to the grand magazine in the earth, after an explosion, of collecting such light bodies as fall in its way into momentary aggregates; which then explode and are dissipated. In the present case, it was probably the soot from the chimney (by an error of the press made 'sand') which afforded the substance of the fire ball. And a consideration of the effects may help us to explain many of the strange appearances which we read of in the accounts of such accidents. Of these I have made a collection, on which at a future time I may publish some remarks.

7. The accumulation and movements of the **smoke of the city**, are frequently noticed in my Observations; but I do not recollect to have stated my opinion; that it is always **electrified-negatively**; and that the attraction exercised for such a body, by clouds or haze charged positively, may often account for its being detained and elevated, as we see happen. The like cause may be assigned for the rising and floating of dust before Thunder: which it does to the degree of thickening the air, and darkening the horizon considerably.

I shall not need, I trust, to apologize to the Reader, for presenting, at the conclusion of my Text, a list of **Errata***: or for requesting that he will bestow the necessary pains and excuse the disfiguring of the work, by correcting them. When I reflect on the long labour of composing and printing these volumes; and the distance from the press at which I have been obliged to revise, I feel more cause to felicitate myself and him, that the mistakes are so few, than to complain that they are so many. I believe that none are left which affect in any essential point the accuracy of the work.

The General Tables of Results, a Table of the Moon's Changes, — for the use of those who may incline to pursue the subject of periodical variations further — and the Index, are all that now remain: and I may express myself well pleased to take leave for the present of this kind of writing — anticipating for my Reader (if he have perused as carefully as I have written) the like satisfaction in the like rational and innocent occupation of his time, which I have myself enjoyed in the composition of this account of the Phenomena of the Climate of London.

* Note: The list of Errata is not reproduced in this edition, as the errors listed have been corrected.

GENERAL TABLES.

[Table A. Temperature.]

MONTHLY MEAN TEMPERATURE IN LONDON for ten Years, from 1797 to 1806.

Year.	First Mo. Jan.	Sec. Mo. Feb.	Third Mo. Mar.	Four. Mo. April	Fifth Mo. May	Sixth Mo. June	Sev. Mo. July	Eight Mo. Aug.	Nin. Mo. Sept.	Ten. Mo. Oct.	Elev. Mo Nov.	Twel. Mo. Dec.
1797	37.32	37.33	39.85	47.41	53.96	57.56	65.48	61.80	56.95	48.95	43.39	42.66
1798	39.62	39.94	42.96	51.60	56.51	64.00	63.86	65.62	58.89	52.17	41.61	35.19
1799	35.09	38.21	39.33	44.06	52.41	58.04	62.32	60.49	56.45	49.67	44.68	34.30
1800	38.67	35.99	39.41	50.99	57.02	57.98	65.58	66.41	60.08	50.04	44.06	40.03
1801	41.05	40.39	46.07	47.64	55.30	60.85	63.01	65.36	61.11	52.72	41.96	37.49
1802	34.62	40.83	43.15	50.98	52.15	59.58	59.14	67.56	60.23	52.18	42.38	39.30
1803	35.27	38.27	44.38	50.41	53.01	59.05	66.28	64.57	55.14	51.07	43.70	42.78
1804	44.98	38.94	43.23	46.29	59.59	63.46	62.80	63.19	61.75	53.46	45.93	37.14
1805	36.17	40.67	44.01	47.98	52.43	57.70	62.09	64.99	61.71	49.59	41.76	40.75
1806	42.46	43.44	42.73	45.70	57.77	62.50	63.96	64.51	59.49	53.19	49.13	48.75
Greatest variation of the Mean	10.36	7.45	6.74	7.54	7.44	6.44	7.14	7.07	6.61	4.51	7.52	14.45

MONTHLY MEAN TEMPERATURE IN THE COUNTRY for Ten years, 1807 to 1816.

1807	34.14	38.37	36.14	46.00	56.78	58.91	64.72	65.27	53.08	53.06	37.54	36.39
1808	35.99	35.91	37.19	43.05	59.91	59.08	67.19	63.51	56.41	47.27	44.13	34.96
1809	36.42	44.92	43.64	43.21	57.01	58.75	61.14	61.49	57.46	50.47	39.63	40.41
1810	35.06	39.42	43.19	48.09	50.98	60.21	61.25	61.62	59.06	51.01	44.34	39.85
1811	32.64	42.08	45.99	51.69	61.10	61.58	61.84	59.33	57.83	56.04	45.40	38.75
1812	36.88	42.37	40.75	43.85	54.75	55.78	58.79	57.83	55.45	49.41	41.53	35.51
1813	34.84	43.67	43.96	48.36	56.72	58.64	63.50	61.33	57.69	48.67	41.33	38.43
1814	26.71	33.17	37.82	50.84	50.56	55.99	64.75	62.17	55.68	46.86	39.85	40.20
1815	32.77	44.48	47.22	48.56	58.72	60.11	61.09	61.94	55.38	49.70	38.34	36.25
1816	36.13	33.39	39.24	45.21	51.30	57.54	59.74	59.00	54.21	49.95	37.26	35.89
Greatest variation of the Mean	10.17	11.75	11.08	8.64	10.54	5.80	8.40	7.44	5.98	9.18	8.14	5.45

[Table A 2. Temperature.]

MONTHLY MEAN TEMPERATURE IN THE COUNTRY for Fifteen Years, from 1817 to 1831.

Year.	First Mo. Jan.	Sec. Mo. Feb.	Third Mo. Mar.	Four. Mo. April	Fifth Mo. May	Sixth Mo. June	Sev. Mo. July	Eight Mo. Aug.	Ninth. Mo. Sept.	Ten. Mo. Oct.	Elev. Mo. Nov.	Twel. Me. Dec.	Av.
1817	38.87	42.91	40.25	43.25	49.11	61.21	59.55	57.84	56.90	43.16	46.68	34.55	47.857
1818	38.32	34.25	39.87	45.90	53.24	64.25	67.47	62.45	57.11	52.93	47.45	35.92	49.847
1819	39.08	39.25	43.87	48.65	55.25	59.11	64.74	65.88	59.00	49.47	39.81	34.12	49.853
1820	30.50	36.10	41.38	49.38	54.69	57.95	61.13	61.51	55.36	47.38	40.80	39.24	47.951
1821	38.17	34.21	42.76	50.12	50.22	55.32	59.59	63.56	60.95	50.71	47.38	43.35	49.695
1822	39.19	43.32	47.34	49.17	57.51	64.68	63.61	62.53	56.05	51.79	46.65	33.55	51.282
1823	30.63	38.66	41.26	45.48	56.42	57.30	61.06	61.71	56.10	47.66	43.11	39.82	48.267
1824	36.95	39.05	40.05	46.35	51.06	58.56	64.10	62.40	59.35	49.11	45.61	41.20	49.482
1825	38.59	38.07	39.70	49.33	54.63	59.51	66.85	65.06	62.88	52.10	40.55	42.52	50.846
1826	33.19	42.59	42.32	50.50	52.53	64.60	67.00	66.72	59.07	52.93	41.10	42.16	51.226
1827	34.15	32.66	44.24	49.65	55.32	60.91	65.97	61.43	59.05	53.43	43.00	44.08	50.324
1828	40.66	41.50	45.22	49.08	58.03	63.05	65.34	62.34	59.55	50.58	44.56	45.09	52.083
1829	32.98	39.32	39.32	46.20	55.79	60.78	61.80	59.74	54.38	48.15	38.78	32.67	47.492
1830	30.97	35.55	46.11	49.55	56.63	57.74	64.35	59.38	54.50	51.13	43.55	35.43	48.741
1831	34.61	41.55	44.76	50.90	53.51	61.05	64.93	64.82	58.67	55.68	42.75	41.70	51.244
Greatest variation of the mean	In Fifteen years.												
	10.16	10.78	8.02	7.05	8.92	9.28	7.94	8.11	8.50	10.27	8.67	12.42	
	In Twenty years												
	13.95	12.26	11.20	8.64	11.99	9.36	8.68	8.89	9.80	12.88	10.19	12.42	

[TABLE B. Temperature]

EXTREMES of TEMPERATURE, in each Month for Ten Years, with the Attendant Winds.

Year	First Mo. Jan.	Second Mo. Feb.	Third Mo. March	Fourth Mo. April	Fifth Mo. May.	Sixth Mo. June
1807	51°NW. SW	57° W. SW	60° Var.	80° SW a E	85°Var. a E	79°NW a NE
	†13W a NW	18N	18 NW a N	22 N	87 Var. a SW	42 NW
1808	51 SW a S	52 SW	54 E	66 W	39 NE	76 W. NW
	†12 NW	17 N	18 E a NE	22 NW	38 Var. E	44 SW.NW.V
1809	56 S	57 SW	66 S	59 W a SW	80 SE	79 E a SE
	†18E	29 W	31 E. S	14 NW	33 W a NW	42 SW
1810	51 SW	56 SW	60 SW	75 NE	74 E	83 NE a SE
	†10 NW a N	11 NW a N	24 E a NE	30 NE	32 N	37 NE
1811	51 NW	54 S. SE	62 Var. NE	77 SE	84 E	*88 Var. a S
	†14 NW	25 NW	26 Var. NE	26 N	39 NE a E	43 N
1812	50 S	54 S	59 SW	58 V.NW.NE	76 SE	75 NW
	26 NW	26 E a N	24 NE	25 NE	32 Var.a NE	39 N
1813	50 SW	57 SW a S	67 NW. SW	69 E	78 NW a S	*85 E. NE
	20 Var. a N	30 Var. NW	24 NE	27 SW	30 W	37N
1814	41 SE. SW	50 SW.S	60 SW	74 SE a N	70 SE. NE	85 W a E
	† 8 NW. N	18 NE. SE. E	21 E. NE	32 SW. NE	31 NW	36 NE
1815	44 NW	57 W	73 Var. SW	70 SE	*80 NW	*80 E a SW
	†17 Var. N	25 W a NW	29 W a NW	28 N	34 W a NW	38 NE
1816	50 W a SW	53 SW	53 SE	70 E. NE.	72 NE	78 NE. Var.
	21NW.SE.SW	†5 E a N	25 E	26 E a SE	29 NW	36 NW a N

Notes: the mark * denotes the greatest elevation of the year, and the mark † the greatest depression.

[TABLE B. Temperature, contd.]

EXTREMES of TEMPERATURE, in each Month for Ten Years, with the Attendant Winds.

Year	Seventh Mo. July	Eight Mo. August	Ninth Mo. Sept.	Tenth Mo. October	Eleventh Mo. Nov.	Twelfth Mo. Dec.
1807	*87° Var.	82°E	72°W. NW	69°SW	55° SW a N	54°SW
	39 E	46 W	26 N	33 N	22 NW	17 NW
1808	*96 S	80 SW	71 NE	65 SW	56 S	53 NW a SW
	44 NE	43 S	34 NW a N	34 NW	25Var. a NE	14 N
1809	81 NE	*82 E a SE	74 Var. Ely	67 NE	53 N	54 SW
	41 NW	45 SW	35 NW	27 NW	22 NW	28 Var. SW
1810	81 Var. W'ly.	83 NE a NW	*85 E a SE	71 E	58 SW	52 Wly.
	41 SW	40 NW	38 N a E	27 NW	29 W	25 SW NW
1811	80 Var. a SE	76 NE. S. SW.	80 Var. E	73 S	62 SW	54 SW. W
	43 NW	42 NW	39 W	38 S	25 E. NW	21 SW. N
1812	75 SE. W	*78 SE	73 W a SW	69 NW a SW	55 SW	52S
	41 NW	43 N	34 NW	32 SW	24 W	†18 NE
1813	82 S	80 SW	75 S	66 W. SW.	58 SW	54 SW
	42 NW	40 N	40 NE	27 Var.a NW	25E	†19E.NW
1814	*91 SE	80 NW	75 SW a SE	67 SW a SE	54 SW	56 SW
	42 NW	37 N	33NE a N	24 NW a N	19 NW a N	25 SW
1815	*80 W	79 SW	79 SE	66 S	57 SW. S	53 SW. SE
	42 N.NE.NW	43 SW	31 NE	32 E	18 NW	21 SW
1816	*81 SW a SE	71 SE	74 S	68 SE	56 W	50 S
	41 NW	44 NE. E	30 NW	29 SE	17 NE	14 N

Notes: the mark * denotes the greatest elevation of the year, and the mark † the greatest depression.

[TABLE B 2. Temperature.]

EXTREMES of TEMPERATURE, in each Month for Fifteen Years, with the Attendant Winds.

Year	First Mo. Jan.	Second Mo. Feb.	Third Mo. March	Fourth Mo. April	Fifth Mo. May.	Sixth Mo. June
1817	52° SW 19 Var.	55° SW 28 NW	59°NW 17 N	61°NW 25 N	72°SE 32 NW	86°NEaSE 34 W
1818	53 SW. W 21 NE	52 SW 20 NW	53 SE 27 N E'ly	68 SW 22 NE	74 NW 33 NE	89 NW 43 E
1819	53 SW 22 SE	52 SW 18 NW	59 SW. W 24NE'ly	68 W. N. 25 E	77 E a SE 31 NE	78 NW 37SW
1820	52 SW 0 E	53 Sly 15 NE	63 NW 21 N	72 Var. a SE 28 NW.	78 SE 26 NE	91 NW 38 NW
1821	52 SW 22 E	52 SW 18 E	58 SW 24 N'ly	78 E 27 NW	73 SW 29 N	81 SW 34 NE
1822	54 SW 24 NW	56 SW 22 SW a NW	72 SW 28 SW	68 S 27 NE	81 SE 33 NE	92 SE 40N
1823	50 SE 4S W	52 SW 27 E	63 E 24 NW	66 SW 25 E	78 S'ly 33 E	79 N 38 NE
1824	54 W 19 SW a N	54 W 24 E	58 NW 23 NE	73 SW J 25 NW	76 SW 29 NW	85 N 34 NE N
1825	54 SW W 24 Var. a N	52 E. SW 25 NW	58 E 21 NE'ly	69 N'ly 25 E	80 W 32 NE	85 NE 35 NE
1826	47 NW 10W	58 S 20 NE	70E 24 NW	70 NW. SE 25 NW	76 SE 28 NE	92 SE 43 NE
1827	50 W. SW 12 NW	57 SE 10 NW E	60 NW 25 N'ly	79 SE 24 SW	79 NW 30 E	80 NE 36 NW
1828	64 W 24 E	65 SW 25 NW	65 SW 23 NW. NE	77 SW NE 29 N E	77 SE 35 NE	87 SE 44 NW. E
1829	48 NW 18 NE. NW	52 E 18 E	64 SW 18 NW	62 E 27 NW	81 NW 38 E. SE	81 SW 36 NW
1830	43 N 11 N. NW	57 W 8 NE	72 W 26 E	76 SE 21 NW	81 SE 33 SE	78 SE 38 NE
1831	48 SW E. 18 N	61 SE 19 S	65 NE 27 NW	69 NW 31 N	77 SE 26 NW	80 W.SW 40 NE

[TABLE B 2. Temperature, contd.]

EXTREMES of TEMPERATURE, in each Month for Fifteen Years, with the Attendant Winds.

Year	Seventh Mo. July	Eight Mo. August	Ninth Mo. Sept.	Tenth Mo. October	Eleventh Mo. Nov.	Twelfth Mo. Dec.
1817	76° S 42 NW	75° NW 34 SW	76° SE. E 33 W	57° S. NE 24 W	59° SW 32 W	54° SW 18 E'ly
1818	93 SE 44 N'ly	93 E a SE 43 N'ly	75 S. 39 NW	71 SW 31 SE	61 SW 30 S	54 S'ly 16 NW
1819	86 SW 42 NW	86 NE 43 W	82 E.a SE 33 N	77 S'ly 22 NW	55 SW 21 NW	56 SW 10 N
1820	86S 40 N	81 SW 38 SW b N	82N 29 NW	62 NE.S 25 N	57 SW 23 NW	57E 21 NE
1821	78 E a SE 36 NE	84 S NW 45 NW. S.E	78 SW 44 NW. W	68 SW 31 SW	63 W 28 W	55 S 27 NW
1822	84 NW 44N	84 E. NW 41 W	77 NW 33 NE	69 SE 30 NW	62 SW 28 N	49 SW 14E
1823	78 W. N 44 NW	82 NW 44 NW	77 W. S 29 NW	65 SE 28 NW	58 E 21 E	54 SW 26 NW
1824	88 NW 42 NE	82 E b SE 43 NW	86 E a SE 27 NW	69 SW 25 W	58 W 25 NW	54 W. SW 24 NW
1825	97 SE 40 NE	92 E 44 NW b N	84 NE 41 NW	68 S'ly 2.5 N	58 NW. SW 22 NW	58 W. SW 25 SW. b NW
1826	89 E 44 NE	88 E 46 NW	76 NW. S 32 E	71 SE 28 SW	54 SW 20 W	55 SE 28 NW
1827	88 SW 43 E. SE	89 SE 41 SE. N'ly	76 S 43 NE	70 NE 32 NE. W	60 NW 19 NW	60 NE 28 NW
1828	89 SE 50 SW N'Iy	79 NW.SE 43 NE	81 W 37 NE. E	72 NW 29 NE	65 SE 24 NW	65 SW 27 NW
1829	78 SW 40 N	79 SE 40 W a NW	68 NW 33 NW	64 SW 30 NW	52 SW. SE 21 NW	47 SW 16 NE
1830	90 SE 45 NW	78 SE 36 N1831W	72 SW 34 NW	71 SW 28 SE	59 W. S 24 NW	52 NE 12 NW
1831	87 NE 48 Var.	82 E 46 SW	76 W'ly 38 SE	71 SW 34 SE	58 W'ly 24 NE	57 SE 25 N

[TABLE C. Barometer]

GREATEST and LEAST HEIGHT of the BAROMETER in each Month for Ten Years, with the attendant Winds.

Year	First Mo. Jan.	Second Mo. Feb.	Third Mo. March	Fourth Mo. April.	Fifth Mo. May	Sixth Mo. June
1807	*30.60 N	30.56 N	30.56 NE	30.23 SW	30.30 NE	30.28 NW
	28.80 NEa SW	28.90 S. SW	29.28 NW	29.22 V. a SW	28.90 SW	29.55 SW
1808	30.51 SW. NE	*30.71 NE	30.46 E a NW	30.29 NW	30.24 SW	30.24 NE
	28.93 S	29.20 SW	29.55 SE	29.09 SW	29.52 SE	29.64 W
1809	30.12 E a NE	30.47 SW	*30.49 W a N	30.36 N	30.32 W	30.39 NE
	28.50 S	28.70 5W	29.11 SE	29.06 SW	29.32 NW	29.25 S
1810	30.48 E a NW	30.50 NW. V	30.17 NE	30.18 E	30.41 E	30.40 E. SE
	29.85 S. SE	28.98 SW	28.81 SW	29.30 SE	29.30 Var.	29.90 NE
1811	30.54 NW	30.20 NW	*30.61 NE	30.23 Var.	30.10 W	30.40 SE a NW
	29.08 E	29.04 SE	29.30 W	29.22 SE	29.48 SE	29.49 NE
1812	30.25 N	30.06 NW	30.35 SE a NE	30.18 S a E	30.27 E. SE	30.40 NE. N
	29.28 SE	29.30 S	29.10 SW a E	29.55 Var. a SW	29.50 S	29.32 SW
1813	*30.50 NW	30.45 NW	*30.50 NW	30.34 NE	30.10 NW	30.20 NE
	29.30 NW	29.27 SW	29.18 SE	29.18 SW	29.39 Var. SW	29.43 NW a NE
1814	30.17 N	*30.42 NE	*30.42 NE	30.20 SE. NE. N	*30.42 NE	30.27 NE a NW
	†28.22 SE. SW	29.12 SW a SE	28.97 SW	29.23 S	29.28Var. a SE	29.58 NW
1815	30.45 NE	30.47 NW	30.22 Var.	30.25 NE	30.23 Var.	30.17 W
	28.88 E a SE	29.28 Var. SE	28.86 S	28.74 Var. N	29.51 NW	29.21 Var. a S
1816	30.38 NE	30.35 N.W.SW	30.27 E	30.07 SE a E	30.12 SE	30.08 NW
	28.87 SE a SW	28.90 SE a S	28.90 S	28.95 W a SW	29.17 NW	29.15 W

Note: the mark * denotes the greatest elevation of the year, and the mark † the greatest depression.

[TABLE C. Barometer, contd.]

GREATEST and LEAST HEIGHT of the BAROMETER in each Month for Ten Years, with the attendant Winds.

Year	Seventh Mo. July	Eight Mo. Aug.	Ninth Mo. Sept.	Tenth Mo. Oct.	Eleventh Mo. Nov.	Twelfth Mo. Dec.
1807	30.19 N	30.15 NW	30.16 NE	30.25 NW	30.04 NW	30.41 NW a SE
	29.55 SW	29.50 SE	29.36 SW	29.03 NW	†28.68 SW	29.24 SW
1808	30.15 NE	30.16 NW	30.29 W	30.33 NE	30.30 NE	30.38 W. N
	29.43 W	29.50 SW	29.28 S	29.15 SW	†28.72 S	29.15 SW
1809	30.16 NW	30.06 Var.	30.13 SW a NE	30.33 NW	30.47 NW a N	30.25 SW
	29.43 V. N'ly	29.24 S	29.20 SE	29.89 SE	29.10 SW	†28.25 SW a SE
1810	30.21 W a N	30.21 NW	30.40 E. NE.	30.35 N. NE	30.15 NE	*30.51 N
	29.44 S	29.52 NW	29.70 SW	29.30 SW	†28.50 E. SW	29.33 W a SW
1811	30.19 NW	30.25 SW.SW	30.29 N. NE	30.21 Var. SW	30.41 W	30.20 NW
	29.75 SE	29.35 SW	28.86 W	†28.65 S. Var.	29.22 SW	28.90 SW a S
1812	30.39 N	30.15 N. NE	30.28 NW	29.98 W. SE	30.38 N	*30.51 NE
	29.40 V. a SW	29.76 SE. SW	29.67 SE	†28.53 SW	28.96 NE	28.98E
1813	30.18 W	30.26 NE	30.29 NW	30.12 NE	30.34 W a SW	30.49 NW
	29.40 W a SW	23.42 S	29.25 SW a S	28.64 SW	29.02 NE. NW	29.09 SE
1814	30.15 SW a NW	30.24 NW	30.24 E	30.20 NE	30.28 NW	30.18 E a S
	29.56 SW a NW	29.40 N a SW	29.52 S	29.03SW a SE	29.12NaW	28.94 SE
1815	30.24 NE	30.25 NW	30.11 NE	30.22 NE	*30.58 NE	30.52SW a NW
	29.47 NW a SW	29.33 NW	29.28 W a SE	29.25 SW	28.95 W a S	†28.85NW a SW
1816	29.96 NW	30.20 NE	30.13 SW	30.13 SE	*30.62 N	*30.62 NW a N
	29.48 Var. SW	29.30 SE	29.22 E a SE	29.09 SE	28.72 SW	†28.63 SW

Note: the mark * denotes the greatest elevation of the year, and the mark † the greatest depression.

[TABLE C2. Barometer]

GREATEST and LEAST HEIGHT of the BAROMETER in each Month for Fifteen Years, with the attendant Winds.

Year	1 Jan.	2 Feb.	3 Mar.	4 April	5 May	6 June
1817	*30.58 N. E 28.75 SW	30.44 NW 29.36 SW	30.51 N W 28.78 W	30.51 NW 29.67 N W	30.16 N 29.16 SE	30.23 NW 29.17 SE
1818	30.43 SW 28 85 W	30.16 SW 28.94 NE	30.30 SE †28.70 S	30.37 NE 29.08 NE	30.35 NE 29.22 NE	*30.33 E 29.53 SW
1819	*30.50 NW 29.10 SE	30.12 NW †28.90 SW	30.34 NW 29.17 SE	30.17 N 29.03 SW	30.17 E 29.45 SE	30.19 NW 29.63 SE
1820	*30.82 NE 28.95 SW	30.42 NE 29.49 SW	30.44 NW 28.91 Var.	30.53 E 29.27 SW	30.38 SW 29.21 SW	30.41 NW 29.57 W
1821	30.70 NE 29.04 E	*30.76 NW 29.33 SE	30.38 N 29.12 SE	30.14 NW 29.26 W	30.27 NW 29.29 NW	30.34 NE 29.65 SW
1822	30.43 W 29.28 SW	*30.76 SW 29.41 SW	30.45W'ly 29.28 W	30.45 N 29.40 S	30.37 N 29.48 NE	30.25 N 29.75 S
1823	30.30 NE 28.97 S'ly	30.30 NW *28.75 NE	30.55 N 29.19 SE	30.53 NE 29.18 NW	30.50 E 29.73 5W	30.39 NE 29.39 Var.
1824	*30.70 NW 28.03 SW	30.50W 29.50 NE	30.39 NW 29.12 N	30.56 NE 29.29 W	30.64 N 29.65 NE	30.43 NE 29.40 SE
1825	30.89 NW 29.62 S	30.72 W 29.68 SW	30.78 E 29.36 NW	30.61 NE 29.45 E	30.50 NE 29.80 SW	30.49 S 29.60 SW
1826	*30.72 NW 29.87 NW	30.58 W 29.55 S	30.59 E 29.70 NE	30.52 NW 29.27 W	30.43 NW 29.84 E'ly	30.56 E'ly 30.03 NE
1827	30.52 NW 29.45 W	30.75 NE 29.52 SE	30.50 NW †29.06 SW	30.48 NW 29.73 E	30.26 NW 29.53 NW	30.45 NW 29.82 SW
1828	30.58 W 29.39 SW	30.62 NW 29.21 SE	30.49 SW 29.22 SW	30.46 NE 29.51 S'ly	30.35 NE 29.35 NE	30.40 NW †29.20 SW
1829	30.59 N 29.31 Var.	*30.73 E 29.31 E	30.47 NE 29.33 NE	30.22 NE †29.15 SE	30.36 NE 29.75 SW	30.37 N 29.42 SE
1830	*30.64 NE †28.93NW	30.49 W 29.56 W	30.56 NW 29.65 SW	30.35 NW 29.40 E	30.33 W'ly 29.40 SE	30.18 SW 29.49 NE
1831	*30.65 NW 29.30 SE	30.49 NW 29.12 NE	30.47 NE 29.30 SW	30.47 NE 29.32 SE	30.39 NE 29.55 NW	30.13 NE 29.69 W
Range.	2.14 in.	2.01 in.	2.08 in.	1.58 in.	1.48 in.	1.39 in.
Greatest and Least height in 15 years	30.89 28.75	30.76 28.75	30.78 28.70	30.61 29.03	30.64 29.16	30.56 29.17

Note: the mark * denotes the greatest elevation of the year, and the mark † the greatest depression.

[TABLE C2. Barometer, contd.]

GREATEST and LEAST HEIGHT of the BAROMETER in each Month for Fifteen Years, with the attendant Winds.

Year	7 July	8 Aug.	9 Sept.	10 Oct.	11 Nov.	12 Dec.
1817	30.00 SW 29.06 SW	30.05 NE 28.90 S	30.10 Var. 29.16 SW	30.25 NE 29.14 S	30.45 NW 29.26 SE	30.10 NW †28.74 SW
1818	30.32 NW 29.76 SW	30.20 NW 29.49 E	30.30 N 29.32 SE	30.35 SW 29.19 W	30.40 SW 29.24 NE	*30.60 NE 29.27 SE
1819	30.21 NW 29.27 SW	30.32 N 29.20 SE	*30.50 N 29.49 NW	30.33 N'ly 29.34 W	30.16 NE 29.18 NW	30.19 NE 29.30 SW
1820	30.24 N 29.36 SW	30.30 NW 29.55 SW	30.43 N'ly 29.55 W	30.60 NE †28.77 SW	30.37 N 29.45 S'ly	30.35 S 29.47 SW
1821	30.32 Var. 29.60 W	30.21 S. E 29.56 W'ly	30.27 N 29.53 SW	30.40 N 29.08 SW	30.38 W 29.42 W	30.36 NW †27.83 S
1822	30.23 NW 29.51 SW	30.28 NW 29.59 SE	30.31 N 29.45 NE	30.25 W 29.45 Var.	30.36 SW 29.35 W'ly	30.66 NE †29.20 SW
1823	30.17 N 29.57 NW	30.32 NW 29.70 W	30.43 N 29.46 SW	30.52 N 29.11 SW	*30.68 E 29.59 SW	30.59 NE 29.10 SE
1824	30.51 N 29.70 SW	30.42 NE 29.65 W	30.35 SW 29.32 S	30.31 W 29.05 SE	30.37 NW †28.71 S	30.60 W 29.02 SW
1825	30.40 NE 29.90 NW	30.45 NW 29.59 SW	30.48 NW 29.65 SE	30.61 N W 29.23 NW	30.47 N W †29.01 S. W.	30.21 W 29.17 E
1826	30.44 NE 29.79 W	30.43 SW 29.85 SW	30.41 NE 29.86 NW	30.32 NW 29.60 SW	30.64 NE †29.25 SW	30.71N'ly 29.34 SW
1827	30.57 NE 29.92 SW	30.53 NW 29.52 SW	30.50 E 29.79 SW	30.52 NW 29.34 SE	30.55 NW 29.27 S	*30.81 W'1y 29.21 S. W.
1828	30.30 NW 29.30 SW	30.42 NW 29.33 S	*30.72 NE 29.47 SW	30.60 NW †29.20 SW	30.32 NW 29.37 SE	30.47 NW 29.29 SW
1829	30.19 N 29.45 NW	30.21 NW 29.31 W	30.30 NW 29.23 SW	30.48 NW 29.49 W	30.51 NE 29.75 SW	*30.73 NE 29.85 NW
1830	30.19 NW 29.50 SW	30.29 NW 29.45 SW	30.41 NW 29.33 W	30.51 NW 29.75 W'ly	30.47 NW 29.23 S	30.54 W 29.00 NE
1831	30.25W'ly 29.68 SE	30.23 N 29.71 E	30.23 NW 29.41 SE	30.39 NW 29.41 SW	30.60 N 29.50 NW	30.55 SW †29.07 SW
Range.	1.51 in.	1.63 in.	1.56 in.	1.84 in.	1.97 in.	2.98 in.
Greatest and Least height in 15 years.	30.57 29.06	30.53 28.90	30.12 29.16	30.61 28.17	30.68 28.71	30.81 27.83

Note: the mark * denotes the greatest elevation of the year, and the mark † the greatest depression.

[TABLE C3. Clock Barometer]

GREATEST and LEAST HEIGHT of the BAROMETER, in each Month for Seventeen Years, with attendant winds.

Year	1 Jan.	2Feb.	3 Mar.	4 April.	5 May.	6 June
1815	30.43 NE 28.76 SE	39.52 NW 29.29 S'ly	30.27 NW †28.74 S	30.32 NE 28.67 SW	30.33 NW 29.55 NW	30.27 W 29.23 E
1816	30.42 SW 28.83 SE	30.40 W 28.79 SE	30.32 NE 28.73 SW	30.10 SW 28.93 SW	30.14 SW 29.00 S	30.10 S'ly 29.13 NW
1817	*30.57 E 28.62 S	30.52 NW 29.33 SW	30.53 NW 28.70 W	30.55 NW 29.66 NW	30.27 N 29.10 SE	30.30 W 29.15 SE
1818	30.40 SW 28.85 SW	30.23 SW 28.80 NE	30.35 NE †28.35 SW	30.37 N E 29.02 SW	30.36 NE 29.22 NE	30.33 E 29.53 SW
1819	*30.50 NW 29.09 SE	30.11 NW †28.89 SW	30.35 NW 29.13 E'ly	30.20 W 29.02 S	30.17 E 29.45 SE	30.24 NW 29.20 W
1820	30.70 NW 28.69 Var.	30.31 N 29.30 S'ly	30.40 NW 28.70 NW	30.50 E 29.10 SW	30.31 SW 29.10 SW	30.40 NW 29.47 NW
1821	30.77 N'ly 28.89 E	*30.80 NW 29.12 SE	30.40 N 28.93 SE	30.14 NW 29.10 W	30.25 NW 29.06 SW	30.33 NE 29.52 SW
1822	30.44 NW 28.98 SW	*30.70 NW 29.13 SW	30.40 SW 29.20 SW	30.36 NE 29.18 S	30.31 N 29.15 E'ly	30.22 N 29.57 S
1823	30.17 NE 28.70 S'ly	30.25 NE †28.45 NE	30.45 N 28.78 SE	30.40 E'ly 28.90 NW	30.40 E 29.35 S	30.28 NE 29.14 Var.
1824	*30.68 N 28.80 SW	30.64 Var. 28.70 SW	†30.29 NW 29.12 N	30.57 NE 29.10 W	30.61 N 29.42 NE	30.36 NE 29.12 S
1825	*30.82 N 29.20 S	30.68 W 29.50 SW	30.75 E'ly 28.90 W	30.35 NE 29.23 SE	30.50 NE 29.65 SW	30.46 NE 29.34 SW
1826	30.65 NW 29.70 NW	30.54 W 29.34 S	30.57 E 29.43 NE	30.44 NW 29.07 W	30.37 NE 29.68 NE	30.54 NE 29.90 NE
1827	30.41 NW 29.06 W	30.65 NE 29.27 SE	30.40 NW †28.72 SW	30.41 NW 29.54 E	30.22 NW 29.12 SW	30.40 NW 29.60 SW
1828	30.51 W 29.13 SW	*30.58 NW †28.92 SE	30.46 SW 28.98 SW	†30.38 NE 29.09 SW	30.35 NE 29.18 NE	30.30 NW 29.12 SW
1829	30.34 N 28.77 Var.	30.38 E 28.90 SE	30.23 NE 29.01 SE	29.98 E †28.50 S'ly	30.35 NE 29.21 W	30.20 N 29.25 S
1830	*30.42 NE 28.70 Var.	30.27 E 28.94 SW	30.40 NW 28.95 SW	30.10 NW 28.70 SW	30.10 W'ly 29.08 S'ly	30.05 NW 29.28 SE
1831	30.42 NW 29.10 Var.	30.23 SW 28.74 SW	30.43 NE 28.84 SW	*30.44 NE 28.90 S	30.18 NW 29.14 SW	30.02 N 29.14 SW
Extremes	30.82 28.69	30.80 28.45	30.75 28.35	30.57 28.59	30.61 29.06	30.54 29.12
Range	2.13 in.	2.35 in.	2.40 in.	2.07 in.	1.55in	1.42 in.

Note: the mark * denotes the greatest elevation of the Year, and the mark † the greatest depression

[TABLE C3. Clock Barometer, contd.]

GREATEST and LEAST HEIGHT of the BAROMETER, in each Month for Seventeen Years, with attendant winds.

Year	7. July	8. Aug.	9. Sept.	10. Oct.	11. Nov.	12. Dec.
1815	30.21 NE 29.53 SW	30.25 NW 29.35 NW	30.20 NE 29.30 SE	30.27 NE 29.23 SW	*30.59 NE 28.90 S	30.55 SW 28.76 SW
1816	29.90 NW 29.26 SW	30.21 NE 29.03 SE	30.22 N 29.34 SW	30.20 SE 29.07 SE	*30.65 N 28.69 SW	*30.65 NW †28.53 SW
1817	30.04 SW 29.07 SW	30.10 NW 28.89 S	30.23 Var. 29.28 SW	30.30 NE 29.15 S	30.50 NW 29.26 SE	30.33 NW †28.43 SW
1818	30.31 NW 29.74 SW	30.28 NW 29.48 E	30.30 N 29.32 E'ly	30.35 SW 29.20 W	30.40 SW 29.23 E'ly	*30.60 N'ly 29.28 SE
1819	30.22 NW 29.27 SW	30.32 N 29.20 SE	*30.50 N 29.46 Var.	30.30 NE 29.28 NW	30.08 SW 29.05 NW	30.20 SW 29.18 SW
1820	30.22 NW 29.30 SW	30.28 W 29.41 SW	30.37 N'ly 29.35 W	30.58 NE †28.52 W'ly	30.30 NE 29.35 SE	30.40 S 29.45 SW
1821	30.30 NW 29.42 SW	30.20 NW 29.39 SW	30.30 N'ly 29.31 SW	30.38 N 28.78 SW	30.31 SW 29.15 SW	30.32 NW †27.80 S
1822	30.20 NW 29.30 SW	30.21 NW 29.37 SE	30.24 N 29.13 NE	30.15 W 29.17 Var.	30.28 SW 29.02 NW	30.59 NE †28.82 SW
1823	30.08 W 29.38 SW	30.21 NW 29.33 SW	30.34 N 28.52 N	30.42 N 28.59 SW	*30.60 E 29.28 S	30.50 NE 28.65 SE
1824	30.50 N 29.50 SW	30.37 N 29.52 SW	30.25 N 29.35 S'ly	30.18 SW 28.75 SE	30.20 W †28.30 S	30.45 W 28.65 SW
1825	30.40 NW 29.85 NW	30.45 N 29.05 SW	30.45 NW 29.44 SE	30.67 NW 28.72 NW	30.42 NW †28.70 NW	30.20 W 28.90 E
1826	30.40 NE 29.71 SW	30.50 W'ly 29.64 SW	30.38 NE 29.02 SE	30.31 SW 29.40 SW	30.60 NE †28.80 SW	*30.70 NE 29.11 SW
1827	30.57 NW 29.71 SW	30.57 NW 29.32 SW	30.44 E 29.50 SW	30.47 N'ly 28.88 SE	30.45 NW 29.00 S	*30.80 SW 28.80 SW
1828	29.90 NW 29.02 SW	30.42 NW †28.92 SW	30.50 NE 29.08 SW	30.50 E †28.92 SW	30.25 NW 29.01 SE	30.33 SW 28.97 SW
1829	29.96 N 28.99 S	30.03 NE 29.75 W	30.13 SW 28.92 SW	30.21 NW 29.20 NW	30.20 NW 29.28 SW	*30.41 NE 29.45 NW
1830	30.26 NE 29.07 W'ly	30.10 SW 29.04 SW	30.10 W'ly 28.95 W'ly	30.40 NW 29.30 SW	30.27 NW †28.58 SW	30.30 NW 28.80 S'ly
1831	30.20 W 29.25 S	30.14 SW 29.33 NW	30.05 NE 29.25 S	30.20 SW 29.00 S	30.31 NE 28.90 SW	30.30 NW †28.26 S
Extremes	30.57 28.99	30.57 28.75	30.50 28.52	30.67 28.52	30.65 28.30	30.80 27.80
Range	1.58 in.	1.82 in.	1.98 in.	2.15 in.	2.35 in	3.00 in.

Note: the mark * denotes the greatest elevation of the Year, and the mark † the greatest depression

[TABLE C 2. Temperature.]

LOWER MEAN IN LONDON

Year.	1 Jan.	2 Feb.	3 Mar.	4 April	5 May	6 June	7 July.	8 Aug.	9 Sept.	10 Oct.	11 Nov.	12 Dec.
1797	34.64	32.21	34.00	40.76	45.96	49.20	56.16	53.58	50.36	44.29	38.76	39.06
1798	36.09	35.10	37.48	44.10	48.70	55.20	56.09	58.00	52.53	47.03	37.83	32.38
1799	32.06	33.82	34.96	39.06	45.48	50.43	55.58	53.38	50.20	45.00	41.10	32.29
1800	35.71	32.71	34.70	45.63	49.74	51.13	56.74	57.64	54.13	44.83	40.00	37.06
1801	37.13	36.82	40.80	39.83	47.25	52.80	55.09	57.35	55.60	47.70	38.46	33.93
1802	31.16	37.00	36.70	43.33	43.76	51.60	51.32	58.77	52.00	46.29	39.10	35.83
1803	33.09	34.57	38.90	43.53	46.67	52.60	57.90	56.51	46.86	45.96	39.70	40.19
1804	42.13	34.89	38.38	40.86	52.41	55.13	55.90	56.35	55.00	48.38	43.06	34.45
1805	33.48	36.53	38.35	41.40	44.96	50.20	55.09	58.03	54.86	45.00	37.96	37.51
1806	38.90	39.35	38.93	40.30	49.87	54.20	57.13	57.16	52.96	48.35	45.20	44.80
Av. of ten years	35.44	35.30	37.32	41.88	47.48	52.25	55.70	56.67	52.45	46.28	40.11	36.75

the Year…. 44.80

LOWER MEAN IN THE COUNTRY

Year.	1 Jan.	2 Feb.	3 Mar.	4 April	5 May	6 June	7 July	8 Aug.	9 Sept.	10 Oct.	11 Nov.	12 Dec.
1807	27.87	31.03	28.93	36.20	48.51	48.50	54.25	55.90	44.03	46.09	32.26	31.54
1808	30.87	30.27	31.38	35.60	49.54	49.73	56.51	54.51	48.76	40.58	38.26	30.58
1809	32.32	39.14	36.64	36.23	46.51	49.30	52.41	53.77	50.70	43.83	34.30	35.41
1810	31.54	34.21	36.87	39.06	40.90	48.46	52.16	52.19	50.10	43.22	39.06	35.38
1811	27.83	36.67	37.29	42.26	51.67	51.33	53.87	50.87	47.66	49.09	39.30	33.03
1812	32.22	37.17	34.58	35.50	46.64	47.36	51.06	51.29	46.20	41.90	36.30	31.80
1813	30.32	37.78	36.25	38.63	47.80	47.76	52.78	50.61	49.16	41.38	34.96	34.67
1814	28.35	27.25	31.90	40.06	40.09	47.06	54.32	52.48	45.26	37.67	33.50	35.03
1815	20.87	38.32	39.35	38.83	47.54	47.83	50.70	51.83	43.10	41.41	31.93	30.48
1816	31.10	26.10	32.48	35.23	41.71	47.73	51.87	51.29	45.33	42.29	30.40	29.96
Av. of ten years	29.33	33.79	34.57	37.76	46.09	48.50	52.99	52.47	47.03	42.74	35.03	32.79

the Year…. 41.10

[TABLE D1. Temperature.]

MEAN TEMPERATURE of every day in the year, in London, on an average of Ten Years: 1797-1806.

	First Mo. Jan.	Sec. Mo. Feb.	Third Mo. Mar.	Four Mo. April	Fifth Mo. May	Sixth Mo. June.	Sev. Mo. July	Eight Mo. Aug.	Nin. Mo. Sept.	Ten. Mo. Oct.	Elev. Mo. Nov.	Twel. Mo. Dec.
1	37.15	39.65	42.05	44.35	51.00	56.00	61.90	67.40	61.05	54.10	48.85	42.30
2	37.90	40.45	43.75	45.50	52.25	56.70	63.40	65.80	61.25	55.90	48.80	41.35
3	37.70	40.85	43.50	45.40	51.30	59.05	63.45	66.50	62.35	56.40	45.75	40.30
4	38.20	38.17	42.20	46.85	52.55	59.55	64.55	65.30	62.35	54.90	44.65	38.85
5	39.30	38.05	40.37	46.80	53.40	59.45	63.00	64.85	61.85	53.65	43.35	42.00
6	38.20	36.70	40.00	46.87	55.10	59.30	62.15	65.00	61.95	54.30	44.90	42.80
7	37.00	35.40	38.87	47.95	55.30	59.95	62.55	64.55	61.35	53.95	44.55	39.95
8	37.20	35.30	39.30	48.80	54.90	59.90	64.15	65.05	60.10	54.70	46.30	40.30
9	36.30	39.00	39.15	48.05	54.40	61.15	64.35	65.60	60.00	54.00	45.15	39.95
10	35.55	39.00	39.70	48.75	53.50	61.15	63.45	65.67	59.60	52.20	44.80	39.35
11	34.85	37.65	40.70	47.40	53.47	58.70	63.55	65.60	59.65	52.45	46.10	39.35
12	34.00	35.75	41.20	46.12	52.90	58.25	63.05	66.35	58.25	50.55	44.60	38.85
13	36.25	36.65	40.50	45.90	51.60	59.70	62.35	64.10	58.90	50.20	44.60	38.60
14	39.30	35.90	42.75	47.27	51.05	60.35	62.60	64.30	60.35	51.05	45.85	38.40
15	39.00	38.30	42.97	49.52	52.20	59.60	61.90	65.00	61.30	51.55	45.70	39.20
16	38.10	37.55	41.72	49.75	53.45	60.50	62.85	64.35	60.62	50.75	44.80	40.40
17	39.00	38.00	42.60	49.80	54.55	61.10	63.70	65.95	61.20	50.00	43.05	39.95
18	40.20	38.25	42.75	50.15	55.00	61.35	63.05	65.45	61.10	52.05	42.40	39.15
19	41.70	38.05	41.05	50.50	55.50	60.55	63.80	65.00	60.70	51.10	41.95	39.35
20	43.10	40.00	41.27	50.05	55.70	61.80	63.90	63.80	60.20	50.00	41.40	40.65
21	43.60	43.45	41.62	50.55	56.40	59.32	62.75	62.55	58.20	50.95	41.55	40.75
22	42.00	44.92	41.87	49.15	57.45	59.35	62.85	62.35	56.80	49.90	41.50	41.35
23	40.45	44.30	43.65	47.50	56.70	58.50	64.45	62.95	57.25	48.45	41.50	40.25
24	40.00	43.80	45.65	48.85	56.80	60.30	63.05	63.03	55.60	48.80	40.90	39.00
25	37.80	42.37	46.40	50.00	58.80	62.00	62.70	62.05	54.75	48.60	41.90	38.70
26	36.75	41.95	46.15	49.40	60.25	61.10	64.25	61.00	55.55	50.30	42.95	39.15
27	39.60	42.82	46.75	50.05	59.40	61.20	64.60	62.10	57.15	48.45	41.90	38.45
28	38.05	40.90	45.40	49.52	59.20	62.25	63.50	64.25	54.75	47.50	42.35	35.50
29	38.42		45.30	48.65	58.90	62.10	63.95	65.10	56.85	47.10	42.00	38.90
30	37.95		45.20	50.00	56.95	62.20	65.35	64.15	55.15	48.50	42.00	40.20
31	39.80		43.85		55.50		66.05	62.65		49.15		37.75

[TABLE D2. Temperature.]

MEAN TEMPERATURE of every day in the Year in the Country, on an average of Ten Years: 1807-1816.

	First Mo. Jan.	Sec. Mo. Feb.	Third Mo. Mar.	Four Mo. April	Fifth Mo. May	Sixth Mo. June.	Sev. Mo. July	Eight Mo. Aug.	Nin. Mo. Sept.	Ten. Mo. Oct.	Elev. Mo. Nov.	Twel. Mo. Dec.
1	36.00	39.75	42.50	44.00	54.50	58.10	60.25	62.15	59.05	51.60	47.15	39.90
2	33.95	40.30	41.85	43.25	52.85	59.00	60.85	64.10	59.55	51.60	45.95	39.00
3	33.50	39.80	40.70	42.35	54.05	57.25	57.15	62.00	59.80	53.60	43.05	40.95
4	34.65	38.50	42.00	42.80	53.00	58.90	56.80	62.15	57.50	54.95	41.90	40.95
5	35.65	40.35	39.00	44.55	53.05	56.00	59.65	62.10	58.85	56.60	41.30	39.40
6	36.05	42.25	40.45	46.80	54.05	55.60	61.35	61.75	56.40	54.80	41.90	39.40
7	34.70	39.35	40.20	46.25	54.10	57.45	61.45	61.85	55.55	53.60	41.30	37.70
8	34.90	39.25	40.80	44.65	55.25	59.15	62.00	60.90	55.65	52.90	42.25	36.15
9	35.95	39.10	40.15	46.30	54.00	57.15	63.40	59.30	57.10	51.25	44.30	35.75
10	36.60	40.85	38.10	47.90	54.25	57.60	62.25	61.70	56.55	51.90	42.65	36.45
11	36.40	42.35	40.54	45.80	56.00	58.80	64.60	61.10	57.15	51.20	42.70	37.05
12	34.90	41.00	40.25	47.40	55.55	58.55	65.00	62.35	54.60	49.65	43.10	39.25
13	34.30	39.55	40.45	47.25	56.65	59.80	64.75	61.45	54.90	51.05	41.10	38.55
14	33.10	38.95	39.05	47.60	55.90	59.00	64.00	62.25	56.05	50.65	40.65	38.00
15	31.10	40.15	38.65	46.80	56.50	57.50	63.30	62.25	57.35	49.90	41.50	38.15
16	33.20	40.25	39.30	46.15	57.15	57.75	61.90	60.95	57.45	50.15	41.20	36.95
17	32.05	37.65	39.95	44.20	58.75	58.00	62.65	61.10	56.70	51.20	41.00	39.05
18	32.05	37.60	40.75	44.30	55.65	59.00	62.00	62.90	56.85	50.60	39.25	39.55
19	32.35	38.70	41.45	46.55	54.65	59.00	63.95	60.45	55.05	51.10	38.55	37.45
20	30.75	38.35	44.35	48.15	55.15	59.15	62.60	60.05	56.70	51.55	40.85	35.70
21	31.10	39.95	45.25	47.00	54.25	59.65	61.00	60.75	57.85	50.30	39.00	33.60
22	30.70	40.30	43.70	48.20	52.30	58.35	62.00	62.65	58.60	50.05	37.80	35.40
23	32.70	38.85	42.65	49.05	54.45	58.75	64.05	62.90	54.80	47.55	38.55	37.20
24	33.20	40.65	40.90	49.10	56.05	58.85	63.80	60.55	55.20	48.15	38.70	36.75
25	32.40	39.95	39.30	49.15	58.25	61.10	65.70	61.90	53.80	47.15	40.65	36.45
26	35.65	39.50	41.75	49.30	58.45	59.20	63.10	60.35	55.60	46.20	40.10	37.65
27	36.05	39.95	43.90	50.35	57.60	59.95	62.95	60.60	53.85	46.55	38.10	35.05
28	35.30	39.97	46.00	50.90	58.60	59.45	63.20	58.85	52.00	45.10	36.95	36.70
29	34.85		44.95	49.40	57.85	61.30	63.65	57.80	53.70	44.95	37.80	37.80
30	35.75		44.15	51.15	58.50	60.60	61.80	61.75	53.20	45.85	38.90	37.20
31	38.90		44.60		60.45		61.15	60.80		46.10		37.25

[TABLE D3. Temperature.]

MEAN TEMPERATURE of every day in the year for London and its environs, on an average of 20 years: 1797-1816.

	First Mo. Jan.	Sec. Mo. Feb.	Third Mo. Mar.	Four Mo. April	Fifth Mo. May	Sixth Mo. June.	Sev. Mo. July	Eight Mo. Aug.	Nin. Mo. Sept.	Ten. Mo. Oct.	Elev. Mo. Nov.	Twel. Mo. Dec.
1	36.57	39.70	42.27	44.17	52.75	57.05	61.07	64.77	60.05	52.85	48.00	41.10
2	35.92	40.37	42.80	44.37	52.55	57.85	62.12	64.95	60.40	53.75	47.37	40.17
3	35.60	40.32	42.10	43.87	52.67	58.15	60.30	64.25	61.07	55.00	44.40	40.62
4	36.42	38.34	42.10	44.82	52.77	59.22	60.67	63.72	59.92	54.92	43.27	39.90
5	37.47	39.20	39.69	45.67	53.22	57.72	61.32	63.47	60.35	55.12	42.32	40.70
6	37.12	39.47	40.22	46.84	54.57	57.45	61.75	63.37	59.17	54.55	43.40	41.10
7	35.85	37.37	39.54	47.10	54.70	58.70	62.00	63.20	58.45	53.77	42.92	38.82
8	36.05	37.27	40.05	46.72	55.07	59.52	63.07	62.97	57.87	53.80	44.27	38.22
9	36.12	39.05	39.65	47.17	54.20	59.15	63.87	62.45	58.55	52.62	44.72	37.85
10	36.07	39.92	38.90	48.32	53.87	59.37	62.85	63.69	58.07	52.05	43.72	37.90
11	35.62	40.00	40.60	46.60	54.74	58.75	64.07	63.35	58.40	51.82	44.40	38.20
12	34.45	38.37	40.72	46.76	54.22	58.40	64.02	64.35	56.42	50.10	43.85	39.05
13	35.27	38.10	40.47	46.57	54.12	59.75	63.55	62.77	56.90	50.62	42.85	38.57
14	36.20	37.42	40.90	47.44	53.47	59.67	63.30	63.27	58.20	50.85	43.25	38.20
15	35.05	39.22	40.81	48.16	54.35	58.55	62.60	63.62	69.32	50.72	43.60	38.67
14	35.65	38.90	40.51	47.95	55.30	59.12	62.37	62.65	59.04	50.45	43.00	38.67
17	35.52	37.82	41.27	47.00	56.65	59.55	63.17	63.52	58.95	50.60	42.02	39.50
18	36.12	37.92	41.75	47.22	55.32	60.17	62.52	64.17	58.97	51.32	46.82	39.35
19	37.02	38.37	41.25	48.52	55.07	59.77	63.87	62.72	57.87	51.10	40.25	38.40
20	36.92	39.17	42.81	49.10	55.42	60.47	63.25	61.92	58.45	50.77	41.12	38.17
21	37.35	41.70	43.44	48.77	55.32	59.49	61.87	61.65	58.02	50.62	40.27	37.17
22	36.35	42.61	42.79	48.67	54.87	58.85	62.42	62.50	57.70	49.97	39.65	38.37
23	36.57	41.57	43.15	48.27	55.57	58.62	64.25	62.92	56.02	48.00	40.02	38.72
24	36.60	42.22	43.27	49.97	56.42	59.57	63.70	61.80	55.40	48.47	39.80	37.87
25	35.10	41.16	42.85	45.97	58.52	61.55	64.20	61.97	54.27	47.87	41.27	37.57
26	36.20	40.72	43.95	49.35	59.35	60.15	63.67	60.67	55.57	48.25	41.52	38.40
27	37.82	41.39	45.32	50.20	58.50	60.57	63.50	61.35	55.50	47.50	40.00	36.75
28	36.67	40.44	45.70	50.21	58.90	60.85	68.35	61.55	53.37	46.30	39.65	36.10
29	36.64		45.12	49.02	58.37	61.70	63.80	61.45	55.27	46.02	39.90	38.35
30	36.85		44.67	50.57	57.72	61.40	63.57	62.95	54.17	47.17	40.45	38.70
31	39.35		44.22		57.97		63.60	61.72		47.62		37.50

[TABLE D. Rain, Winds, &c.]

TABLE of the WINDS and RAIN, with the number of Days on which Rain fell in each Month, for Ten Years

Year.	1 January N-E.E-S.S-W.W-N.V.	2 February N-E.E-S.S-W.W-N.V.	3 March. N-E.E-S.S-W.W-N.V.	4. April N-E.E-S.S-W.W-N.V.	5. May N-E.E-S.S-W.W-N.V.	6 June. N-E.E-S.S-W.W-N.V.
1807 Rain	4. 2. 7. 17. 1. †0.48 in. 7 d.	4. 0. 11. 10. 3. †0.95 in. 14d	18. 2. 2. 6. 3. †0.62 in. 7d	9. 4. 11. 1. 5. †0.25 in. 6d.	5. 7. 10. 2. 7. †2.36 in. 17d.	3. 0. 7. 14. 6. †1.44 in. 6d.
1808 Rain	2. 0. 17. 10. 2. †1.08 in. 11 d.	7. 2. 5. 13. 2 †0.68 in. 11 d.	20. 8. 0. 3. 0. †0.21 in. 4 d.	6. 0. 7. 11. 6. †1.56 in. 15 d.	4. 5. 15. 1. 6. †1.40 in. 12 d.	6. 2. 6. 9. 7. †0.83 in. 9 d.
1809 Rain	6. 8. 7. 6. 4. †3.83 in. 22 d.	0. 3. 21. 3. 1. †1.08 in 22d.	13. 6. 1. 6. 5 †0.41 in. 9 d.	9. 2. 8. 7. 4. †2.93 in. 24 d.	2. 8. 13. 4. 4. †0.73 in. 13 d.	7. 3. 11. 7. 2. *0.94 in. 11 d.
1810 Rain	5. 12. 8. 3. 3. †0.11 in. 16 d.	4. 2. 13. 6. 3. †0.87 in. 23 d.	6. 8. 11. 2. 4. †1.80 in. 15 d.	7. 11. 7. 3. 2. †0.97 in. 10 d.	11. 7. 4. 6. 3. *1.30 in. 10 d.	6. 6. 1. 9. 8. *0.50 in. 4 d.
1811 Rain	9. 5. 4. 10. 3. 1.21 in. 12 d.	1. 10. 12. 5.0. 1.77 in. 15 d.	8. 5. 3. 11. 4. 0.96 in. 7 d.	6. 5. 5. 7. 7. 0.99 in. 13 d.	4. 9. 10. 3. 5. 2.52 in. 20 d.	9. 3. 9. 7. 2. 1.81 in. 11 d.
1812 Rain	6. 2. 7.14.2. 1.84 in. 13 d.	1. 7. 7. 10. 4. 3.47 in. 22 d.	11. 8. 6. 5. 1. 2.93 in. 22 d.	15. 2. 3. 5. 5. 1.46 in. 14 d.	5. 10. 11. 3. 2. 2.36 in. 19 d.	6. 1. 16. 3. 4. 2.85 in. 16 d.
1813 Rain	7. 9. 3.10. 2. 0.85 in. 13 d.	0. 0. 19. 8. 1. 2.42 in. 15 d.	3. 3. 10. 12. 3. 0.68 in. 9 d.	8. 8. 5. 9. 0. 1.97 in. 12 d.	4. 3. 6. 11. 7. 2.80 in. 23d.	12. 4. 4. 8. 2. 2.66 in. 14 d.
1814 Rain	11. 5. 2. 7. 6. 3.71 in. 19 d.	9. 7. 7. 4. 1. 0.36 in. 11 d.	14. 6. 6. 2. 3. 2.02 in. 18 d.	4. 7. 10. 8. 1. 1.35 in. 15 d.	12. 9. 1. 6. 3. 2.62 in. 9 d.	7. 7. 2. 14. 0. 2.32 in. 23 d.
1815 Rain	13. 4. 3. 6. 5 1.07 in. 12 d.	0. 6. 11. 8. 3. 1.17 in. 14 d.	0. 1. 15. 12. 3. 2.34 in. 20 d.	11. 5. 2. 6. 6. 2.09 in. 19 d.	4. 2. 12. 10. 3. 1.10.in. 18 d.	7. 3. 10. 9. 1. 1.85 in. 13d.
1816 Rain	5. 6. 12. 8. 0. 2.15 in. 19 d.	6. 3. 11. 7. 2. 2.09 in. 14 d.	6. 7. 12. 6. 0. 2.25 in. 16 d.	8. 12. 2. 7. 1. 1.93 in. 12 d.	8. 5. 8. 10. 0. 2.02 in. 17 d.	8. 1. 6. 11. 4. 4.08 in. 11 d.
Averages	6,8. 5,3. 7,0. 9,1. 2,8 1,633. 14,4.	3,2. 4,0. 11 ,7. 7,4. 2,0 1,486. 15,8.	9,8. 5,4. 6,6. 6,5. 2,6 1,422. 12,7.	8,3. 5,6. 6,0. 6,4. 3,7. 1,550. 14,0.	5,9. 6,5. 9,0. 5,6. 4,0 1,921. 15,8.	7,1. 3,0. 7,2. 9,1. 3,6. 1,928. 11,8.

Note: The results marked † were obtained at about 43 feet elevation from the ground, and those to which no mark is annexed, upon or near the ground.
The mark * denotes that the result is in part an estimate.

[TABLE D. Rain, Winds, &c., contd.]

TABLE of the WINDS and RAIN, with the number of Days on which Rain fell in each Month, for Ten Years

Year.	7 July. N-E.E-S.S-W.W-N.V.	8 August N-E.E-S.S-W.W-N.V.	9 September. N-E.E-S.S-W.W-N.V.	10 October. N-E.E-S.S-W.W-N.V.	11 November. N-E.E-S.S-W.W-N.V	12 December. N-E.E-S.S-W.W-N.V.
1807 Rain	2. 2. 15. 8. 4. †0.13 in. 8 d.	2. 8. 8. 12. 1. 1.54 in. 9 d.	5. 1. 8. 13. 3. 1.47 in. 7 d.	3. 3. 12. 10. 3. 1.17 in. 10 d.	5. 2. 11. 9. 3. †2.83 in. 11 d.	1. 3. 11. 12. 4. †0.21 in. 6 d.
1808 Rain	7. 4. 12. 6. 2. 3.37 in. 15 d.	5. 1. 12. 12. 1. 2.24 in. 15 d.	5. 3. 9. 8. 5. 2.51 in. 18 d.	2. 2. 11. 16. 0. 3.07 in. 15 d.	10. 3. 10. 5. 2. †1.57 in. 10 d.	8. 8. 4. 9. 2. †0.65 in. 16 d.
1809 Rain	7. 3. 4. 15. 2. *2.76 in. 15 d.	1. 2. 22. 5. 1. *1.76 in. 21 d.	3. 4. 8. 11. 4. †2.11 in. 23 d.	9. 7. 7. 5. 3. 0.18 in. 11 d.	11. 2. 5. 12. 0. †1.38 in. 16 d.	0. 2. 16. 10. 3. †1.52 in. 24 d.
1810 Rain	5. 2. 10. 9. 5. 3.68 in. 20 d.	2. 3. 3. 22. 1. 2.91 in. 17 d.	13. 7. 2. 7. 1. 0.65 in. 6 d.	12. 4. 7. 4. 4. 3.18 in. 11 d.	8. 8. 5. 4. 5. 5.32 in. 22 d.	2. 2. 7. 18. 2. 5.02 in. 19 d.
1811 Rain	9. 3. 7. 9. 3. 3.76 in. 13 d.	1. 2. 14. 12. 2. 2.74 in. 19 d.	5. 13. 4. 6. 2. 1.73 in. 11 d.	0. 2. 21. 2. 6. 2.63 in. 19 d.	3. 1. 14. 11. 1. 2.30 in. 15 d.	3. 1. 16. 10. 1. 2.22 in. 19 d.
1812 Rain	5. 3. 10. 8. 5. 3.12 in. 12 d.	7. 4. 6. 10. 4. 1.56 in. 14 d.	4. 7. 8. 7. 4. 0.53 in. 6 d.	0. 6. 10. 13. 2. 4.00 in. 25 d.	11. 6. 8. 5. 0. 2.47 in. 13 d.	11. 10. 1. 8. 1. 0.65 in. 16 d.
1813 Rain	1. 2. 8. 20. 0. 3.31 in. 13 d.	8. 2. 5. 15. 1. 0.74 in. 15 d.	10. 5. 8. 7. 0. 1.07 in. 13 d.	8. 5. 7. 7. 4. 4.82 in. 21 d.	5. 5. 9. 11. 0. 1.35 in. 15 d.	10. 7. 8. 6. 0. 0.89 in. 16 d.
1814 Rain	1. 4. 12. 14. 0. 1.07 in. 18 d.	2. 0. 12. 17. 0. 2.37 in. 18 d.	11. 9. 7. 3. 0. 1.37 in. 14 d.	10. 3. 10. 7. 1. 2.46 in. 16 d.	9. 0. 10. 9. 2. 2.72 in. 17 d.	6. 8. 12. 5. 0. 3.70 in. 24 d.
1815 Rain	7. 1. 5. 16. 2. 1.40 in. 20 d.	2. 2. 12. 12. 3. 2.26 in. 13 d.	2. 6. 13. 7. 2. 1.39 in. 11 d.	7. 5. 15. 3. 1. 2.66 in. 15 d.	10. 0. 8. 9. 3. 1.54 in. 16 d.	5. 1. 15. 9. 1. 2.33 in. 17 d.
1816 Rain	1. 1. 12. 10. 7. 3.00 in 27 d.	5. 5. 8. 12. 1. 2.90 in. 22 d	6. 5. 13. 5. 1. 2.39 in. 14 d.	1. 13. 5. 7. 5. 2.23 in. 19 d.	6. 4. 8. 9. 3. 2.59 in. 15 d.	4. 4. 9. 10. 4. 3.74 in. 20 d.
Averages	4,5.2,5,9,5.11,5.3,0 2,758. 16,1	3,5.2,9.10,2.13.1,5. 2,102. 16,3.	6,4.6,0.8,0.,7,4.2,2 1,522. 12,3.	5,2.5,0.10,5.7,4.2,9 2,740. 16,2.	7,8.3,1.8,8.8,4.2,0. 2,407. 15,0.	5,0.4,6.9,9.9,7.1,8. 2,093. 17,7

Note: The results marked † were obtained at about 43 feet elevation from the ground, and those to which no mark is annexed, upon or near the ground. The mark * denotes that the result is in part an estimate.

[TABLE D.2. Rain, Winds, &c.]

TABLE of the WIND and RAIN, with the number of Days on which Rain fell in each Month, for Ten Years

Year	1 Jan. N-E.E-S.S-W.W-N.V.	2 Feb. N-E.E-S.S-W.W-N.V.	3 March. N-E.E-S.S-W.W-N.V.	4. Apr. N-E.E-S.S-W.W-N.V.	5. May N-E.E-S.S-W.W-N.V.	6 June. N-E.E-S.S-W.W-N.V.
1817 24.83	2. 3. 16. 4. 6. 3.99 in. 21 d.	0. 0. 10. 16. 2. 1.30 in. 19 d.	3. 4. 5. 14. 5. 1.69 in. 15 d.	16. 4. 1. 7. 2 0.24 in. 12 d.	11. 4. 6. 7. 3. 3.11 in. 19 d.	4. 6. 9. 10. 1. 2.34 in. 12 d.
1818 26.15	0. 2. 14. 9. 6. 2.57 in. 23 d.	6. 5. 7. 3. 7. 2.85 in. 13 d.	3. 2. 15. 10. 1. 3.75 in. 25 d.	6. 10. 8. 2. 4. 3.60 in. 19 d.	12. 5. 8. 5. 1. 2.77 in. 15 d.	1. 9. 10. 9. 1. 0.63 in. 12 d.
1819 23.78	1. 9. 11. 9. 1. 2.19 in. 16 d.	1. 4. 8. 13. 2. 2.77 in. 22 d.	8. 2. 8. 11. 2. 1.01 in. 14 d.	5. 10. 8. 6. 1. 2.45 in. 16 d.	8. 12. 5. 6. 0. 2.47 in. 12 d.	0. 2. 15. 12. 1. 1.80 in. 15 d.
1820 23.66	6. 4. 11. 8. 2. 1.83 in. 18 d.	10. 5. 6. 6. 2. 1.01 in. 13 d.	10. 2. 6. 11. 2. 0.37 in. 11 d.	7. 6. 7. 9.1. 1.58 in. 11 d.	2. 5. 14. 8. 2. 2.85 in. 17 d.	3. 2. 2. 22. 1. 2.54 in. 16 d.
1821 31.36	5. 12. 9. 4. 1. 2.89 in. 13 d.	6. 5. 4. 11. 2. 0.31 in. 6d.	4. 3. 13. 9. 2. 2.92 in. 24 d.	5. 3. 6. 15. 1. 1.52 in. 17 d.	7. 3. 7. 13. 1. 1.84 in. 14 d.	19. 1. 2. 6. 2. 2.22 in. 11 d.
1822 22.77	5. 1. 5. 20. 0. 0.62 in. 8 d.	1. 3. 16. 8. 0. 0.82 in. 8 d.	2. 1. 15. 12. 1. 1.60 in. 14 d.	9. 7. 9. 4. 1. 2.44 in. 22 d.	17. 7. 2. 5. 0. 1.58 in. 11d.	11. 9. 6. 3. 1. 1.19 in. 7 d.
1823 24.08	11. 11. 4. 4. 1. 2.05 in. 15 d.	6. 3. 6. 12. 1. 2.92 in. 19 d.	5. 7. 5. 14. 0. 1.17 in.14 d	8. 7. 4. 10. 1. 1.81 in. 13 d.	4. 7. 15. 4. 1. 0.98 in. 14 d.	13. 0. 6. 9. 2. 1.88 in. 10 d.
Averages 25.80	4,3. 6. 10. 8,3. 2,4. 2.31 in. -	4,3. 3,6. 7,9. 9,9. 2,3 1.85 in. -	5. 3. 9,6. 11,6. 4,8. 1.79 in. -	8. 6,7. 6. 7,7. 1,6. 1.95 in. -	8,7. 6,1. 8,2. 7,0. 1. 2.23 in -	7,3. 4,1. 7,1. 10,2. 1,3. 2.23 in.

[TABLE D.2. Rain, Winds, &c., contd.]

TABLE of the WIND and RAIN, with the number of Days on which Rain fell in each Month, for Ten Years

Year	7 July. N-E.E-S.S-W.W-N.V.	8 Aug. N-E.E-S.S-W.W-N.V.	9 Sept. N-E.E-S.S-W.W-N.V.	10 Oct. N-E.E-S.S-W.W-N.V.	11 Nov. N-E.E-S.S-W.W-N.V	12 Dec. N-E.E-S.S-W.W-N.V.
1817 24.83	0. 2. 17. 12. 0. 2.50 in. 16 d.	2. 2. 18. 9. 0. 2.16 in. 18 d.	12. 7. 3. 4. 4. 0.48 in. 7 d.	18. 4. 6. 3. 0. 1.34 in. 18 d.	1. 6. 13. 9. 1. 1.49 in. 12 d.	8. 5. 9. 4. 5. 4.19 in. 18 d.
1818 26.15	6. 6. 7. 8. 4. 0.57 in. 10 d.	12. 3. 3. 11. 2. 0.10 in. 4 d.	4. 9. 8. 8. 1. 3.48 in. 22 d.	3. 10. 11. 6. 1. 1.82 in. 11 d.	3. 11. 12. 3. 1. 2.85 in. 17 d.	9. 5. 6. 8. 3. 1.16 in. 9 d.
1819 23.78	12. 1. 4. 13. 1. 1.45 in. 8 d.	13. 3. 1. 13. 1. 0.41 in. 4 d.	9. 5. 7. 8. 1. 2.58 in. 12 d.	8. 3. 7. 13. 0. 2.09 in. 15 d.	7. 1. 5. 17. 0. 2.12 in. 15 d.	7. 3. 15. 5. 1. 2.45 in. 16d.
1820 23.66	9. 4. 4. 10. 4. 3.38 in. 10 d.	8. 0. 14. 9. 0. 1.82 in. 12 d.	8. 4. 5. 12. 1. 2.49 in. 14 d.	8. 4. 10. 9. 0. 2.30 in. 16 d.	8. 11. 4. 4. 3. 1.82 in. 17 d.	5. 10. 7. 9. 0. 1.67 in. 16 d.
1821 31.36	4. 5. 6. 15. 1. 2.82 in. 12 d.	4. 7. 10. 10. 0. 2.16 in. 13 d.	2. 3. 9. 14. 2. 2.65 in. 19 d.	4. 6. 12. 9. 0. 2.51 in. 17 d.	1. 5. 15. 9. 0. 4.67 in. 22 d.	0. 7. 12. 12. 0. 4.85 in. 25 d.
1822 22.77	3. 2. 13. 11. 2. 3.23 in. 14 d.	2. 5. 4. 20. 0. 1.39 in. 14d.	12. 5. 5. 8. 0. 1.46 in. 9 d.	1. 11. 11. 6. 2. 3.62 in. 23 d.	5. 0. 18. 5. 2. 3.46 in. 21 d.	14. 7. 6. 4. 0. 1.36 in. 6 d.
1823 24.08	1. 2. 13. 14. 1. 2.43 in. 21 d.	2. 1. 10. 18. 0. 2.09 in. 23 d.	7. 2. 7. 14. 0. 1.65 in. 8 d.	6. 9. 8. 7. 1. 3.00 in. 13 d.	3. 6. 12. 9. 0. 1.72 in. 8 d.	1. 2. 13. 15. 0. 2.33 in. 18 d.
Averages 25.8	5. 3. 9. 12. 2. 2.34 in. -	6,1. 3. 8,5. 13. 0,4. 1.45 in. -	7,7. 5. 6,3. 9,7. 1,3. 2.11 in. -	6,9. 6,7. 9,3. 7,6, 0,5 2.38 in. -	4. 6. 11. 8. 1. 2.59 in. -	6,3. 5,6. 9,7. 8,1. 1,3 2.57 in. -

[TABLE D.3. Rain, Winds, &c.]

TABLE of the WINDS and RAIN, with the number of Days on which Rain fell in each Month, for eight Years.

Year	1 Jan. N-E.E-S.S-W.W-N.V.	2 Feb. N-E.E-S.S-W.W-N.V.	3 Mar. N-E.E-S.S-W.W-N.V.	4 April N-E.E-S.S-W.W-N.V.	5 May N-E.E-S.S-W.W-N.V.	6 June N-E.E-S.S-W.W-N.V.
1824 31.49	2. 0. 11. 16. 2. 0.87 in. 8 d.	6. 10. 5. 7. 1. 2.31 in. 17d.	10. 1. 6. 13. 1. 2.05 in. 18 d.	8. 6. 5. 10. 1. 2.05 in. 18 d.	14. 4. 5. 8. 0. 3.79 in. 17 d.	13. 5. 8. 3. 1. 3.67 in. 15 d.
1825 21.88	9. 0. 6. 15. 1. 0.95 in. 12 d.	2. 5. 6. 15. 0. 0.98 in. 10 d.	9. 12. 5. 5. 0. 0.76 in. 10 d.	8. 8. 6. 8. 0. 1.55 in. 10 d.	10. 7. 10. 4. 0. 3.45 in. 10 d.	7. 3. 11. 9. 0. 0.68 in. 12 d.
1826 22.56	5. 12. 2. 12. 0. 0.20 in. 6 d.	2. 3. 14. 9. 0. 1.54 in. 16 d.	8. 7. 7. 9. 0. 1.46 in. 11 d.	1. 5. 2. 21. 1. 1.12 in. 10 d.	15. 7. 1. 8. 0. 2.77 in. 12 d.	11. 5. 2. 12. 0. 1.18 in. 4 d.
1827 24.19	3. 3. 8. 17. 0. 1.15 in. 20 d.	12. 6. 3. 6. 1. 0.88 in. 11 d.	1. 1. 12. 17. 0. 2.42 in. 20 d.	5. 7. 8. 10. 0. 0.90 in. 17 d.	2. 8. 10. 8. 3. 2.07 in. 14 d.	6. 2. 10. 12. 0. 0.75 in. 15 d.
1828 28.66	1. 10. 12. 8. 0. 4.05 in. 16 d.	4. 6. 5. 14. 0. 0.93 in. 16 d.	2. 2. 9. 18. 0. 0.96 in. 13 d.	5. 3. 11. 11. 0. 2.56 in. 17 d.	8. 13. 2. 8. 0. 1.50 in. 11 d.	3. 6. 3. 17. 1. 3.37 in. 14 d.
1829 24..60	13. 6. 1. 9. 2. 0.51 in. 11 d.	2. 12. 3. 11. 0. 0.87 in. 13 d.	11. 12. 1. 4. 2. 0.55 in. 7 d.	2. 7. 11. 10. 0. 3.98 in. 25 d.	7. 9. 2. 13. 0. 0.44 in. 9 d.	3. 6. 8. 12. 1. 2.14 in. 15 d.
1830 26.52 Av.	11. 6. 0. 11. 2. 2. 1.42 in. 22 d. 6,6. 5,3. 6. 12,1. 1,0.	6. 2. 6. 14. 0. 1.65 in. 16 d. 4,9. 6,3. 6. 10,9. 0,3.	0. 10. 5. 16. 0. 0.58 in. 8 d. 6. 6,4. 6,4. 11,7. 0,5.	0. 6. 9. 15. 0. 3.00 in. 14 d. 4,1. 6,7. 4. 12,2. 0,3.	2. 12. 6. 11. 0. 2.09 in. 15 d. 8,3. 8,6. 8,1. 8,6. 0,4.	3. 6. 7. 14. 0. 3.34 in. 19 d. 6,6. 4,7. 7. 11,3. 0,4.
1831 29.29	8. 13. 5. 5. 0. 0.96 in. 14 d.	1. 7. 5. 15. 0. 2.52 in. 18 d.	6. 5. 6. 14. 0. 1.99 in. 15 d.	13. 8. 5. 4. 0. 1.96 in. 10 d.	12. 9. 2. 8. 0. 1.36 in. 10 d.	6. 0. 7. 17. 0. 1.43 in. 13 d.
Averages						
25.70	7 years 1.31	1.31	1.25	2.44	2.3	2.16
26.15	8 years 1.26	1.46	1.34	2.14	2.18	2.07
25.72	15 years 1.71	1.57	1.55	2.05	2.2	2.01

[TABLE D.3. Rain, Winds, &c., contd.]

TABLE of the WINDS and RAIN, with the number of Days on which Rain fell in each Month, for eight Years.

Year	7 July N-E.E-S.S-W.W-N.V.	8. Aug. N-E.E-S.S-W.W-N.V.	9. Sept. N-E.E-S.S-W.W-N.V.	10. Oct. N-E.E-S.S-W.W-N.V.	11. Nov. N-E.E-S.S-W.W-N.V.	12. Dec. N-E.E-S.S-W.W-N.V.
1824 31.49	8. 5. 7. 10. 1. 1.68 in. 12 d.	10. 2. 8. 11. 0. 2.01 in. 17 d.	7. 5. 8. 10. 0. 3.77 in. 18 d.	3. 8. 7. 13. 0. 2.37 in. 17 d.	1. 2. 10. 17. 0. 3.82 in. 19 d.	3. 0. 12. 16. 0. 3.10 in. 21 d.
1825 21.88	9. 11. 2. 9. 0. 0.09 in. 3 d.	4. 7. 9. 11. 0. 2.93 in. 15 d.	3. 4. 13. 10. 0. 2.53 in. 10 d.	4. 5. 9. 13. 0. 2.27 in. 15 d.	2. 0. 9. 19. 0. 2.99 in. 19 d.	2. 6. 8. 15. 0. 2.70 in. 18 d.
1826 22.56	7. 3. 11. 10. 0. 2.61 in. 10 d.	6. 6. 9. 10. 0. 1.87 in. 11 d.	4. 10. 9. 7. 0. 3.43 in. 15 d.	0. 11. 11. 8. 1. 2.05 in. 14 d.	9. 1. 6. 14. 0. 2.72 in. 15 d.	5. 9. 5. 12. 0. 1.61 in. 14 d.
1827 24.19	2. 5. 8. 15. 1. 1.37 in. 9 d.	7. 5. 6. 13. 0. 1.99 in. 16 d.	9. 5. 14. 2. 0. 3.26 in. 14 d.	4. 13. 6. 8. 0. 4.49 in. 15 d.	3. 5. 5. 16. 1. 1.28 in. 14 d.	1. 4. 14. 12. 0. 3.63 in. 21 d.
1828 28.66	1. 3. 12. 15. 0. 6.15 in. 25 d.	4. 4. 7. 16. 0. 2.94 in. 13 d.	6. 12. 8. 4. 0. 2.57 in. 13 d.	3. 4. 7. 17. 0. 0.95 in. 9 d.	2. 9. 9. 10. 0. 1.02 in. 7 d.	1. 7. 13. 10. 0. 1.66 in. 13 d.
1829 24..60	4. 2. 11. 14. 0. 4.01 in. 22d.	3. 4. 7. 17. 0. 5.11 in. 21 d.	1. 3. 11. 15. 0. 3.35 in. 19 d.	1. 2. 6. 22. 0. 1.79 in. 11 d.	7. 6. 4. 13. 0. 1.61 in. 12 d.	15. 8. 3. 4. 1. 0.24 in. 11 d
1830 26.52 Av.	4. 6. 9. 11. 1. 1.79 in. 13 d. 5. 5. 8,6. 12. 0,4.	2. 3. 11. 15. 0. 3.83 in. 17 d. 5,1. 4,4. 8,1. 13,3. 0.	2. 1. 14. 13. 0. 3.22 in. 21 d. 4,6. 5,7. 11. 8,7. 0.	4. 6. 9. 12. 0. 1.00 in. 8 d. 2,7. 7. 8. 13,2. 0.1.	1. 6. 12. 11. 0. 3.21 in. 14 d. 3,6. 4,1. 8. 14,2. 0,1.	4. 8. 4. 15. 0. 1.39 in. 13 d. 4,5. 6. 8,4. 12. 0,1.
1831 29.29	8. 3. 7. 13. 0. 2.90 in. 12 d.	10. 5. 4. 12. 0. 3.69 in. 11 d.	2. 7. 6. 15. 0. 4.93 in. 15 d.	0. 6. 16. 9. 0. 3.35 in. 15 d.	2. 1. 5. 22. 0. 1.66 in. 14 d.	6. 4. 13. 8. 0. 2.54 in. 18 d.
Averages						
25.7	7 years 2.53	2.95	3.16	2.13	2.38	2.04
26.15	8 year 2.57	3.04	3.38	2.28	2.29	2.11
25.72	15 years 2.46	2.3	2.79	2.33	2.43	2.32

[TABLE E1. Temperature.]

HIGHER MEAN IN LONDON

Year.	1 Jan.	2 Feb.	3 Mar.	4 April	5 May	6 June	7 July.	8 Aug.	9 Sept.	10 Oct.	11 Nov.	12 Dec.
1797	40.00	42.46	45.70	54.06	61.96	65.93	74.80	70.03	63.55	53.61	48.03	46.32
1798	43.16	44.78	48.45	59.10	64.32	72.80	71.64	73.25	65.26	57.32	45.40	38.00
1799	38.12	42.60	43.70	49.06	59.35	65.66	69.06	67.61	62.70	54.35	48.26	36.32
1800	41.64	39.28	44.12	56.36	64.31	64.83	74.42	75.19	66.03	55.25	48.13	43.00
1801	44.97	43.96	51.35	55.46	63.35	68.90	70.93	73.38	66.63	57.74	45.46	41.06
1802	38.09	44.67	49.61	58.63	60.54	67.56	66.96	76.35	68.46	58.67	45.66	42.77
1803	37.45	42.00	49.87	57.30	59.35	65.50	74.67	72.64	63.43	56.19	47.70	45.38
1804	47.84	43.00	48.09	51.73	66.77	71.80	69.71	70.03	68.50	58.54	48.80	39.83
1805	38.87	44.82	49.67	54.56	59.90	65.20	69.09	71.96	68.56	54.19	45.56	44.00
1806	46.00	47.53	46.54	51.10	65.67	70.90	70.70	71.87	66.03	58.03	53.06	51.06
Av. of ten years	41.61	43.51	47.71	54.73	62.50	67.90	71.19	72.23	65.91	56.38	47.60	42.77

the Year…. 56.17

HIGHER MEAN IN COUNTRY

Year.	1 Jan.	2 Feb.	3 Mar.	4 April	5 May	6 June	7 July.	8 Aug.	9 Sept.	10 Oct.	11 Nov.	12 Dec.
1807	40.42	45.71	43.35	55.80	65.06	69.33	75.19	74.67	62.13	60.03	42.83	41.25
1808	41.12	41.55	43.00	50.50	70.29	68.43	77.87	72.51	64.06	53.96	50.00	39.35
1809	40.51	50.71	50.64	50.20	67.51	68.20	69.87	69.22	64.23	57.12	44.96	45.42
1810	38.58	44.64	49.51	57.13	61.06	71.96	70.35	71.06	68.03	58.80	49.63	44.32
1811	37.45	47.50	54.70	61.13	70.54	71.83	69.80	67.80	68.00	63.00	51.50	44.48
1812	41.54	47.58	46.93	52.20	62.87	64.20	66.52	64.38	64.70	56.93	46.76	39.22
1813	39.16	49.57	51.67	58.10	65.64	69.53	74.22	72.06	66.23	55.96	47.70	42.19
1814	37.19	39.10	43.74	61.63	61.03	64.93	75.19	71.87	66.10	56.06	46.20	45.38
1815	32.55	50.64	55.09	58.30	69.90	72.40	71.48	72.16	67.66	58.00	44.76	42.03
1816	41.16	40.69	46.00	55.20	60.90	67.36	67.61	66.71	63.10	57.61	44.13	41.83
Av. of ten years	38.96	45.76	48.46	56.02	65.48	68.82	71.81	70.24	65.42	57.74	46.85	42.55

the Year…. 56.51

[TABLE E1. Temperature]

HIGHER MEAN IN THE COUNTRY.

Year.	1 Jan.	2 Feb.	3 Mar.	4 April	5 May	6 June	7 July.	8 Aug.	9 Sept.	10 Oct.	11 Nov.	12 Dec.
1817	43.22	48.82	48.81	50.00	59.97	72.37	69.97	71.26	65.60	50.81	52.47	40.35
1818	44.13	40.53	47.13	54.73	64.16	77.80	77.77	74.39	65.40	61.97	53.07	41.64
1819	45.42	46.21	50.29	58.20	66.45	69.47	76.58	77.68	69.23	58.19	45.47	40.61
1820	37.00	43.07	49.77	61.13	65.58	68.97	71.97	72.26	67.57	54.81	47.07	43.32
1821	43.00	41.18	50.29	59.90	61.39	67.07	70.35	73.97	69.23	59.19	53.33	48.68
1822	44.61	50.43	56.13	58.27	70.55	79.80	74.58	73.52	66.63	59.29	52.73	39.39
1823	35.64	43.78	48.55	54.90	68.29	69.30	70.58	71.10	68.20	55.93	48.33	45.58
Averages	41.86	44.86	50.14	56.73	65.19	72.11	73.11	73.45	67.32	57.17	50.35	42.79

LOWER MEAN IN THE COUNTRY.

Year.	1 Jan.	2 Feb.	3 Mar.	4 April	5 May	6 June	7 July.	8 Aug.	9 Sept.	10 Oct.	11 Nov.	12 Dec
1817	33.26	38.78	31.71	33.83	40.16	49.87	49.13	47.97	48.17	35.52	40.90	28.74
1818	32.52	28.18	32.77	37.07	42.32	50.70	54.58	50.52	48.89	43.90	41.83	30.19
1819	32.45	32.64	39.45	39.10	44.52	48.77	52.74	54.10	48.77	40.70	34.17	27.64
1820	24.00	29.13	33.00	37.63	43.84	46.97	50.29	50.77	43.16	39.93	34.53	35.16
1821	33.35	27.25	35.22	41.00	39.06	43.57	48.84	53.16	52.67	42.23	41.43	38.03
1822	33.45	35.86	38.55	40.07	44.93	49.56	52.90	51.58	46.13	44.29	40.57	28.03
1823	25.61	33.21	33.97	35.73	44.55	45.30	51.55	12.29	43.87	39.39	37.90	34.06
Averages	30.66	32.15	34.67	37.77	42.77	47.82	51.43	50.05	47.38	40.85	38.76	31.69

[TABLE E. Evaporation.]

MONTHLY AMOUNTS of EVAPORATION in Inches and Decimal Parts.

Year	First Mo. Jan.	Sec. Mo. Feb.	Thir. Mo. March.	Fourth Mo. April.	Fifth Mo. May	Six. Mo. June.	Sev. Mo. July	Eig. Mo. Aug.	Nin. Mo. Sept.	Ten. Mo. Oct.	Elev. Mo. Nov.	Twel.Mo. Dec.	Annual Averages
	With the Guage at 40 feet elevation												
1807	0.52 Frosty: damp air	1.64	2.66	3.60 much Electricity	5.08	4.52	6.03	5.04	4.17	2.98	1.86	0.94 Frosty with Snow	37.85 Inches
1808	1.19	1.65	3.23 Rain very deficient.	3.22 Rain an average.	5.39	3.99	5.51	3.82	2.95	2.39	2.02	1.14	
1809	1.24	2.40 Mean T. 44º92	2.79 Mean T. 43º64	2.49 Mean T. 43º21	6.07 Mean T. 57º01	†4.14		†4.74	3.02	2.63	1.27	1.58	
	With the Guage variously situated												
1810	1.04	†1.28	2.71				4.85	4.56	3.45	2.76	0.79 Rain in excess	1.68	33.37 Inches
1811	1.05	†2.24	2.85	3.14	3.75	4.53	3.66	3.64	3.91	2.65	1.64	1.53	
1812	1.25	2.30 Stormy.	1.95	3.19	4.35	4.23	3.65	2.38	2.7		0.61		
	With the Guage at the ground, the first two months excepted												
1813	0.45	2.14 Mean T. 43º67 much wind.	1.64 Mean T. 43º96 much wind.	2.20	2.25	2.93	3.22	3.04	2.31	0.90 much Rain after fair weather	0.63	0.21 Fogs, preceding frost	20.28 Inches
1814	0.25 Severe Frost.	†0.36 Frosty	0.83 Frosty with Snow	2.16	2.14	1.89	3.42	4.48	2.04	1.15 wet	0.53	0.71 wet and frosty	
1815	0.50	0.78	1.45	1.81	2.14	†1.83	2.55						
Monthly Averages	0.832	1.643	2.234	2.726	3.896	3.507	4.111	3.962	3.068	2.208	1.168	1.112	30.50 Inches

Note: the amounts marked † are in part estimated, some days in each month having been omitted to be taken.

[TABLE F. Barometer.]

MEAN RESULTS of LUNAR PERIODS, arranged by the Solar Year.

Year		BRUMAL PERIODS Solstice			VERNAL PERIODS. Equinox			ESTIVAL PERIODS. Solstice			AUTUMNAL PERIODS. Equinox			
1806-7	Period 1 29.54 in.	2 29.84 in.	3 29.78 in.	4 29.86 in.	5 29.94 in.	6 29.73 in.	7 29.78 in.	8 29.89 in.	9 29.81 in.	10 29.85 in.	11 29.76 in.	12 29.84 in.	13 29.47 in.	
1807-8		14 29.80	15 29.82	16 30.02	17 30.16	18 29.86	19 29.87	20 29.89	21 29.97	22 29.76	23 29.77	24**e** 29.78	25 29.76	
1808-9	26 29.86	27 29.52	28 29.44	29 30.17	30 29.81	31 29.83	32 29.73	33 29.92	34 29.75	35 29.66	36 29.84	37 30.08	38 29.86	
1809-10		39 29.76	40 30.07	41 29.91	42 29.67	43 29.72	44 29.80	45 30.14	46 29.94	47 29.85	48 30.46	49**e** 29.91	50 29.59	
1810-11	51 29.66	52 29.88	53 29.80	54 29.82	55 30.12	56 29.70	57 29.88	58 30.02	59 29.83	60 30.03	61 29.74	62 29.61	63 29.90	
1811-12		64 29.71	65 29.90	66 29.74	67 29.74	68 29.90	69 29.81	70 29.88	71 29.97	72 29.97	73 30.04	74 29.47	75 29.68	
1812-13		76 29.88	77 30.02	78 29.96	79 30.11	80 30.00	81 29.68	82 29.89	83**s** 29.87	84 29.80	85 30.11	86**e** 29.75	87 29.62	88 29.73
1813-14		89 29.76	90 29.59	91 28.89	92 29.84	93 29.77	94 29.91	95 29.90	96 29.92	97 29.88	98 29.94	99 29.66	100 29.63	
1814-15		101 29.66	102 29.77	103 29.78	104 29.67	105 29.78	106 29.81	107 29.71	108 29.96	109 29.88	110 29.89	111 29.75	112 29.78	113 29.84
1815-16		114 29.61	115 29.69	116 29.60	117 29.76	118 29.68	119 29.85	120 29.81	121 29.77	122 29.87	123 29.84	124 29.51	125 29.86	
1816-17		126 29.65	127 29.84	128 29.59	129 30.07	130 30.03	131 29.53	132 29.75	133 29.74	134 29.63	135 29.84	136 29.88	137 29.88	
1817-18		138 29.51	139 29.78	140 29.66	141 29.47	142 29.64	143 29.76	144 30.00	145 30.04	146 30.05	147 29.86	148**e** 29.70	149 29.83	150 29.93
1818-19		151 30.07	152 29.52	153 29.77	154 29.74	155 29.83	156 29.90							General average of 10 yrs. 29.823
Av. of each column on ten years		29.745	29.788	29.875	29.870	29.797	29.812	29.899	29.879	29.854	29.883	29.736	29.725	

NOTE. Period 1 is not included in the average for the Winter Solstice: the mean of 39 is calculated up to the New Moon in the following period: 83 has the Summer Solstice, and the periods marked **e** the Autumnal Equinox about their beginning: the rest include the points under which they stand. In 45 and 48, the mean is taken in each case 0.06 in. lower than it stands in may Results, the Barometer employed for them being known to be too high.

[TABLE F2. Barometer.]

MEAN RESULTS of LUNAR PERIODS, arranged by the Solar Year.

Year.	BRUMAL PERIODS Solstice.			VERNAL PERIODS Equinox.			ESTIVAL PERIODS. Solstice.			AUTUMNAL PERIODS Equinox.		
From Dec. 9,1816 1817	29.56	29.90	29.66	29.97	30.04	29.61	29.77	29.73	29.67	29.91	29.94	†29.88
Dec. 5, 1817 1818	*92·66	29.75	29.46	29.77	29.51	30.11	29.95	30.06	29.91	29.66	29.92	29.82
Dec. 8, 1818 1819	†30·02	29.58	29.77	29.79	29.77	29.88	29.87	30.26	29.98	29.96	29.82	29.80
Dec. 6, 1819 1820	29.87	29.84	29.88	29.90	29.87	†29·74	29.97	29.91	29.85	29.98	29.44	29.83
Dec. 2, 1820 1821	29.90	29.80	30.20	29.60	29.82	†29·74	29.86	29.93	29.88	29.80	29.87	†29.75
Dec. 6, 1821 1822	29.34	30.10	30.10	29.99	29.83	29.89	30.02	29.73	29.83	29.88	29.61	†29.69
Dec. 2, 1822 1823	30.08	29.88	29.39	29.75	29.65	29.85	29.89	29.71	29.77	30.00	29.60	To Dec. 6 *29.93 1823
Averages	29.776	29.835	29.723	29.824	29.784	28.831	29.904	29·904.	29.841	29.884	29.743	29.814
	29.778			29.800			29.883			29.833		

In the annexed Table, the mean height of the Barometer for each space equal to a Lunar month, included between the 9th Dec. 1816, and the 6th of the same 1823, is set down in such a way as to bring the spaces including the Solstices and Equinoxes under those points respectively. In order to effect this, it was needful to put into two of the results [marked *] six, and into six others [marked †,] five weeks each. The limits of the space having been three days (wherever practicable,) one each side the **phase**, four of these spaces making the month, with whatever phase it began.

[TABLE F3. Barometer]

Mean Height of Barometer for each month, from 1824 to 1830, obtained at the Laboratory.

Year.	1 Jan.	2 Feb.	3 March	4 April	5 May	6 June	7 July.	8 Aug.	9 Sept.	10 Oct.	11 Nov.	12 Dec.	Average
1824	30.083	29.883	29.899	29.934	29.952	20.871	29.953	29.832	29.861	29.557	29.945	29.770	29.879
1825	30.239	30.075	30.187	29.899	30.035	30.050	30.194	29.996	29.943	29.648	29.681	29.894	29.987
1826	30.104	30.098	30.040	30.032	30.063	30.283	30.010	30.027	29.947	29.964	29.858	29.956	30.032
1827	29.824	30.071	29.717	30.013	29.816	29.989	30.126	30.081	30.002	29.166	29.969	29.879	29.938
1828	29.980	30.007	30.074	29.892	29.811	30.011	29.714	29.876	29.825	30.116	29.943	30.040	29.941
1829	29.960	30.165	29.950	29.642	30.060	29.983	29.806	29.890	29.837	29.900	30.100	29.280	29.959
1830	30.133	30.069	30.179	29.863	29.913	29.885	29.947	29.903	29.668	30.275	29.946	29.775	29.980
Averages	30.046	30.052	30.007	29.896	29.950	30.010	29.964	29.943	29.869	29.889	29.920	29.942	29.950

Note: The Laboratory is situate nearly level with the Thames at the highest tides

[TABLE F4. Barometer]

Mean Height of Barometer for each month, from 1824 to 1830, obtained at the Laboratory.

Year.	1. Jan.	2 Feb.	3. March	4. April	5. May	6. June	7. July	8 Aug.	9 Sept.	10 Oct.	11 Nov.	12 Dec.	Average
1824	30.083	29.883	29.899	29.934	29.952	29.871	29.953	29.832	29.861	29.557	29.945	29.770	29.861
1825	30.239	30.075	30.187	29.899	30.035	30.050	30.194	29.996	29.943	29.648	29.681	29.894	29.987
1826	30.104	30.098	30.040	30.032	30.063	30.283	30.010	30.027	29.947	29.964	29.858	29.956	30.032
1827	29.824	30.071	29.717	30.013	29.816	29.989	30.126	30.081	30.002	29.766	29.969	29.879	29.938
1828	30.010	29.871	29.958	29.692	28.819	29.931	29.551	29.739	29.807	29.910	29.678	29.709	29.806
*1829	29.691	29.852	29.726	29.389	29.838	29.763	29.522	29.595	29.498	29.730	29.739	29.920	29.689
*1830	29.790	29.693	29.846	29.517	29.695	29.632	29.726	29.663	29.521	30.004	29.549	29.415	29.671
Averages	29.963	29.934	29.910	29.782	29.858	29.931	29.869	29.847	29.797	29.797	29.774	29.863	29.855

Note: * These Results were obtained at Ackworth.

[TABLE G. Temp.]

MEAN RESULTS of LUNAR PERIODS, arranged by the Solar Year. *For the Decade.*

Year.		BRUM. PE. Av. 37°.76 Solstice			VERNAL Pe. Av. 48°.94 Equinox			ESTIVAL PE. Av. 60°.66 Solstice			AUTUMNAL PE. Av. 49°.37 Equinox			
1806-7	Period 1 [44°60]	2 42°.53	3 34°.7 5	4 38°.2 1	5 36°.28	6 51°.12	7 55°.4 1	8 59°.00	9 66°.0 8	10 64°.9 6	11 52°.94	12 53°.0 0	13 37°.92	
1807-8		14 36.26	15 36.98	16 35.91	17 38.11	18 41.82	19 55.18	20 59.41	21 65.60	22 65.30	23 60.34	24 *e* 48.84	25 45.36	
1808-9	26 41.01	27 33.68	28 40.86	29 42.46	30 44.01	31 48.58	32 58.89	33 59.37	34 61.95	35 61.15	36 55.20	37 47.74	38 39.32	
1809-10		39 40.82	40 36.43	41 37.63	42 42.08	43 47.00	44 50.53	45 54.20	46 62.00	47 59.98	48 60.65	49 56.00	50 45.48	
1810-11	51 41.15	52 35.86	53 38.05	54 43.93	55 46.75	56 57.19	57 63.19	58 60.00	59 61.00	60 59.20	61 57.85	62 54.86	63 42.95	
1811-12		64 38.06	65 38.00	66 41.73	67 41.50	6 8 43.67	69 55.46	70 55.89	71 58.34	72 57.83	73 54.93	74 51.46	75 41.31	
1812-13		76 36.68	77 36.25	78 40.58	79 42.50	80 49.11	81 54.79	82 57.93	83 61.69	84 63.88	85 58.44	86 55.28	87 43.41	88 39.63
1813-14		89 32.36	90 31.31	91 31.93	92 44.14	93 51.39	94 50.50	95 60.01	96 65.50	97 60.20	98 53.79	99 46.43	100 39.05	
1814-15		101 40.13	102 32.66	103 44.43	104 47.44	105 48.56	106 58.58	107 60.10	108 61.36	109 62.13	110 57.00	111 50.79	112 41.75	113 35.96
1815-16		114 36.52	115 32.00	116 39.46	117 39.66	118 50.83	119 54.15	120 60.30	121 60.40	122 55.29	123 55.90	124 43.12	125 35.80	
Av. of each column on ten years		37.92	35.73	39.63	42.25	48.92	55.67	58.62	62.39	60.99	56.70	50.75	40.48	

Note.- Period 1 is not included in the average for the Winter Solstice: the mean of 39 is calculated up to the New Moon in 40: period 83 has the Summer Solstice, and the periods marked *e* have the Autumnal Equinox, about their beginning: the rest include the points under which they are placed in the column. For the application of the Results contained in this Table see page *** in this volume.

[TABLE G2. Temperature.]

MEAN RESULTS of LUNAR PERIODS for the Septenary, arranged by the Meteorological Seasons.

Year begins	BRUMAL PERIODS. Mean 37.28º Solstice			BRUMAL PERIODS. Mean 50.16º Equinox			ESTIVAL PERIODS. Mean 61.36º Solstice			ESTIVAL PERIODS. Mean 49.78º Equinox		
Dec. 9 1816	37.31	41.19	42·76	38.93	42.19	51.04	60.38	58.80	58.24	57.20	44.42	*45.95
Dec. 5 1817	†35.87	33.49	39.48	42.31	50.68	57.95	64.44	66.77	64.92	54.92	52.41	45.71
Dec. 8 1818	*35.08	38.00	40.66	48.33	51.73	58.17	60.85	64.80	65.01	57.05	48.16	39.65
Dec. 6 1819	32.47	30.92	36.41	42.86	48.81	*54·57	61.33	63.03	60.73	54.38	47.20	38.56
Dec. 2 1820	39.90	37.44	30.14	42.92	49.89	*51·25	55.07	30.39	63.43	61.99	50.77	*48.33
Dec. 6 1821	42.50	39.97	42.89	47.96	49.76	58.08	64.72	64.02	61.25	56.68	49.62	*45.54
Dec. 2 1822	33.23	29.46	38.74	43.32	50.44	58.26	57.50	61.33	59.45	56.00	48.07	42.81
Averages	36.62	35.78	39.44	43.80	49.07	57.62	60.61	62.75	60.72	56.89	48.66	†43.79
Range of variation	10.03	11.73	7.75	10.40	9.54	7.22	9.65	7.97	6.77	7.61	7.61	9.71

These results are a mean of four or more averages of the Medium daily temperature upon spaces equal to Lunar weeks; but taken from a point between the phases, pacing the day of New of Full Moon, or of either quarter, in the midst of the space, with a view to better to ascertain its effects on the temperature: on which subject see the head "Of Periodical Variations" in this volume. The Results marked * include five Lunar weeks, and those marked †, six each.

[Table H. Rain corrected]

Monthly amounts of Rain for 14 years, corrected for the elevation of the Guage.

Rate of addition for the ground.	0.5	0.45	0.4	0.3	0.2	0.1	0.05	0.1	0.2	0.3	0.4	0.45	
Year	1 Jan.	2. Feb.	3 Mar.	4 April.	5 May.	6. June.	7. July	8. Aug.	9 Sept.	10 Oct.	11 Nov.	12 Dec.	Amount for the year
1797	1.440 in.	0.317 in.	1.087 in.	2.416 in.	1.723 in.	4.645 in.	1.352 in.	3.067 in.	4.873 in.	2.601 in.	2.062 in.	2.335 in.	27.918 in.
1798	1.657	1.004	0.466	0.672	1.945	1.056	3.022	1.677	2.294	4.456	4.278	1.242	24.399
1799	1.423	3.240	0.606	2.172	2.098	0.607	3.058	2.429	3.388	2.848	2.221	0.506	24.596
1800	3.687	0.377	0.427	3.750	1.304	1.096	0.000	1.612	3.250	1.670	5.322	2.422	24.917
1801	1.839	0.788	1.551	0.488	1.810	0.870	3.700	1.725	1.516	1.916	4.611	3.651	24.465
1802	0.219	2.175	0.555	1.282	1.436	2.048	2.956	0.568	0.806	2.133	1.419	1.734	17.330
1803	2.316	1.078	0.628	1.422	2.022	3.694	1.436	0.830	1.102	0.616	3.417	4.486	23.047
1804	2.509	1.938	2.154	2.085	1.497	0.574	3.890	3.081	0.000	2.659	5.590	0.732	26.709
1805	2.269	1.515	1.234	2.057	1.021	3.615	2.279	3.888	1.830	1.797	1.113	2.608	25.226
1806	2.755	0.775	1.859	0.318	1.224	0.555	5.133	2.295	2.304	1.030	3.571	3.939	25.758
1807	0.720	1.370	0.860	0.320	2.830	1.580	0.320	1.690	1.770	1.520	3.960	3.200	20.140
1808	1.620	0.980	0.290	2.020	1.680	0.910	3.370	2.240	3.010	3.990	2.190	0.940	23.240
1809	5.740	1.560	0.570	3.800	0.870	1.030	2.890	1.930	2.530	0.230	1.930	2.200	25.280
1810	0.165	1.260	2.520	1.260	1.560	0.550	3.680	2.910	0.650	3.180	5.320	5.020	28.070

TABLE OF LUMINATIONS.
FOR THE WHOLE SPACE OCCUPIED BY THE REGISTER:
Compiled from White's Ephemeris.

N.B.— The minutes are always in **addition** to the hour; the mark (a) denotes that the **time expressed** is between midnight and noon, and (p) that it is between noon and midnight. Refer **back on the line** for the month.

	NEW MOON				FIRST QUARTER				FULL MOON				LAST QUARTER			
Year.		day	h.	m.		day	h.	m.		day	h.	m.		day	h.	m.
1806	Nov.	10	11	41a.		18	7	20a.		26	2	1a.	Dec.	2	10	44p.
	Dec.	10	2	24a.		18	4	31a.		25	3	p.				
1807													Jan	1	6	57a.
	Jan.	8	7	36p.		16	12	26a.		24	2	31a.		30	5	18p.
	Feb.	7	2	15p.		15	5	35p.		22	12	47p.	Mar	1	6	21a.
	Mar.	9	8	52a.		17	7	5a.		23	10	9p.		30	9	45p.
	Apr.	8	2	7a.		15	4	38p.		22	7	15a.		29	2	39p.
	May	7	5	6p.		14	10	59p.		21	4	42p.		29	8	3a.
	June	6	5	24a.		13	3	30a.		20	3	10a.		28	1	15a.
	July	5	3	15p.		12	7	53a.		19	3	11p.		27	5	46p.
	Aug.	3	11	27p.		10	1	52p.		18	5	10a.		26	9	4a.
	Sept.	2	7	5a.		8	10	46p.		16	9	6p.		24	10	34p.
	Oct.	1	3	13p.		8	11	21a.		16	2	30p.		24	9	56a.
		31	12	42a.	Nov.	7	3	45a.		15	8	14a.		22	7	16p.
	Nov.	29	11	58a.	Dec.	6	11	21p.		15	12	55a.		22	3	17a.
	Dec.	29	1	9a.												
1808					Jan.	5	8	54p.		13	3	31p.		20	11	6p.
	Jan.	27	4	9p.	Feb.	4	6	31p.		12	3	53a.		18	7	47p.
	Feb.	26	8	43a.	Mar.	5	1	55p.		12	2	21p.		19	5	53a.
	Mar.	27	2	11a.	Apr.	4	5	28a.		10	11	26p.		17	5	36p.
	Apr.	25	7	28p.	May	3	4	42p.		10	7	39a.		17	7	2a.
	May	25	11	19a.	June	1	12	23a.		8	3	34p.		15	10	8p.
	June	24	12	56a.	July	1	5	45a.		7	12	3a.		15	2	53p.
	July	23	12	18p.		30	10	21a.	Aug.	6	10	5a.		14	8	41a.
	Aug.	21	10	10p.		28	3	40p.	Sept.	4	10	41p.		13	2	30a.
	Sept.	20	7	27a.		26	10	56p.	Oct.	4	2	18p.		12	7	6p.
	Oct.	19	4	54p.		26	9	10a.	Nov.	3	8	27a.		11	9	41a.
	Nov.	18	2	55a.		24	11	3p.	Dec.	3	3	35a.		10	9	52p.
	Dec.	17	1	36p.		24	4	43p.								
1809									Jan.	1	9	53p.		9	7	51a.
	Jan.	16	1	9a.		23	1	23p.		31	2	8p.	Feb.	7	4	13p.
	Feb.	14	1	59p.		22	11	2a.	Mar.	2	3	57a.		8	11	43p.
	Mar.	16	4	19a.		24	7	18a		31	3	23p.	Apr.	7	7	9a.
	Apr.	14	7	57p.		22	12	27a.		30	12	41a.	May	6	3	26p.
	May	14	12	4p.		22	1	55p.		29	8	18a.	June	5	1	30a.
	June	13	3	42a.		20	11	58p.		27	3	7p.	July	4	2	2p.
	July	12	6	13p.		20	7	25a.	July	26	10	14p.	Aug.	3	5	21a.
	Aug.	11	7	33a.		18	1	20p.		25	7	3a.	Sept.	1	11	4p.
	Sept.	9	7	58p.		16	6	51p.		23	6	38p.	Oct.	1	6	10p.
	Oct.	9	7	42a.		16	1	12a.		23	9	25a.		31	1	22p.
	Nov.	7	6	49p.		14	9	40a.		22	2	57a.		30	7	18a.
	Dec.	7	5	21a.		13	9	17p.		21	10	p.		29	10	47p.

	NEW MOON				FIRST QUARTER				FULL MOON				LAST QUARTER			
Year.		day	h.	m.		day	h.	m.		day	h.	m.		day	h.	m.
1810	Jan.	5	3	37p.		12	12	32p.		20	5	6p.		28	11	14a.
	Feb.	4	2	8a.		11	6	53a.		19	10	58a.		26	8	37p.
	Mar.	5	1	23p.		13	2	47a.		21	2	31a.		28	3	39a.
	Apr.	4	1	37a.		11	10	32p.		19	3	8p.		26	9	28a.
	May	3	2	46p.		11	4	41p.		19	1	10a.		25	3	25p.
	June	2	4	38a.		10	8	20a.		17	8	18a.		23	10	47p.
	July	1	7	6p.		9	9	9p.		16	2	50p.		23	8	40a.
		31	10	10a.	Aug.	8	7	20a.		14	9	46p.		21	9	43p.
	Aug.	30	1	35a.	Sept.	6	3	24p.		13	6	17a.		20	2	5p.
	Sept.	28	4	46p.	Oct.	5	10	14p.		12	5	6p.		20	9	17a.
	Oct.	28	6	58a.	Nov.	4	4	57a.		11	6	29a.		19	6	8a.
	Nov.	26	7	44p.	Dec.	3	12	43p.		10	10	20p.		19	2	47a.
	Dec.	26	7	9a.												
1811					Jan.	1	10	30p.		9	4	16p.		17	9	11p.
	Jan.	24	5	45p.		31	10	56a.	Feb	8	11	27a.		16	12	3p.
	Feb.	23	4	3a.	Mar.	2	1	56a.		10	6	18a.		17	11	3p.
	Mar.	24	2	12p.		31	6	56p.	Apr.	8	11	3p.		16	6	48a.
	Apr.	22	12	19a.		30	1	3p.	May	8	12	39p.		15	12	26p.
	May	22	10	42a.		30	7	12a.	June	6	11	7p.		13	5	16p.
	June	20	10	2p.		28	12	18a.	July	6	7	26a.		12	10	43p.
	July	20	11	4a.		28	3	34p.	Aug.	4	2	53p.		11	6	7a.
	Aug.	19	2	12a.		27	4	42a.	Sept.	2	10	35p.		9	4	39p.
	Sept.	17	6	57p.		25	3	48p.	Oct	2	7	16a.		9	7	1a.
	Oct.	17	12	9p.		25	1	16a.		31	5	19p.	Nov.	8	1	16a.
	Nov.	16	4	28a.		23	9	36a.		30	7	9a.	Dec.	7	10	24p.
	Dec.	15	7	11p.		22	5	30p.		29	7	11p.				
1812													Jan.	6	8	19p.
	Jan.	14	8	18a.		21	1	49a.		28	11	38a.	Feb.	5	4	40p.
	Feb.	12	8	p.		19	11	27a.		27	5	51a.	Mar.	6	9	49a.
	Mar.	13	6	22a.		19	11	p.		27	12	16a.	Apr.	4	11	5p.
	Apr.	11	3	27p.		18	12	41p.		26	5	10p.	May	4	8	37a.
	May	10	11	39p.		18	4	16a.		26	7	34a.	June	2	3	10p.
	June	9	7	50a.		16	9	7p.		24	7	33p.	July	1	7	53p.
	July	8	5	13p.		16	2	25p.		24	5	45a.		30	12	18a.
	Aug.	7	4	55a.		15	7	28a.		22	2	59p.		29	6	1a.
	Sept.	5	7	22p.		13	11	39p.		20	11	51p.		27	2	32p.
	Oct.	5	12	10p.		13	2	25p.		20	8	51a.		27	2	53a.
	Nov.	4	6	14a.		12	3	15a.		18	6	30p.		25	7	20p.
	Dec.	3	12	20a.		11	1	51p.		18	5	23a.		25	3	7p.
1813	Jan.	2	5	21p.		9	10	27p.		16	6	4p.		24	12	34p.
	Feb.	1	8	36a.		8	6	2a.		15	8	43a.		22	9	44a.
	Mar.	2	9	30p.		9	1	43p.		17	12	48a.		25	4	46a.
	Apr.	1	7	55a.		7	10	28p.		15	5	20p.		23	8	25p.
		30	4	14p.	May	7	8	54a.		15	9	26a.		23	8	8a.
	May	29	11	21p.	June	5	9	17p.		14	12	32a.		21	4	16p.
	June	28	6	26a.	July	5	11	40a.		13	2	24p.		20	9	57p.
	July	27	2	43p.	Aug.	4	4	1a.		12	2	57a.		19	2	43a.
	Aug.	26	1	8a.	Sept.	2	10	p.		10	2	13p.		17	8	8a.
	Sept.	24	2	11p.	Oct.	2	4	46p.		10	12	31a.		16	3	34p.

	NEW MOON				FIRST QUARTER				FULL MOON				LAST QUARTER			
Year.		day	h.	m.		day	h.	m.		day	h.	m.		day	h.	m.
1813	Oct.	24	5	56a.	Nov.	1	10	58a.		8	10	23a.		15	2	1a.
	Nov.	22	11	58p.	Dec.	1	3	3a.		7	8	25p.		14	3	53p.
	Dec.	22	7	15p.		30	4	10p.								
1814									Jan.	6	7	8a.		13	9	3a.
	Jan.	21	2	13p.		29	2	22a.	Feb.	4	6	46p.		12	4	45a.
	Feb.	20	7	11a.		27	10	26a.	Mar.	6	7	15a.		14	1	30a.
	Mar.	21	9	6p.		28	5	21p.	Apr.	4	8	29p.		12	9	23p.
	Apr.	20	7	55a.		26	12	6a.	May	4	10	29a.		12	2	41p.
	May	19	4	23p.		26	7	31a.	June	3	1	15a.		11	4	27a.
	June	17	11	32p.		24	4	33p.	July	2	4	34p.		10	2	54p.
	July	17	6	26a.		24	4	3a.	Aug.	1	7	51a.		8	10	54p.
	Aug.	15	2	5p.		22	6	46p.		30	10	26p.	Sept.	7	5	34a.
	Sept.	13	11	18p.		21	12	41p.		29	11	53a.	Oct.	6	11	58a.
	Oct.	13	10	51a.		21	8	49a.		28	12	16a.	Nov.	4	7	4p.
	Nov.	12	1	15a.		20	5	16a.		27	11	52a..	Dec.	4	3	45a.
	Dec.	11	6	36p.		19	12	5a.		26	11	p.				
1815													Jan.	2	2	52p.
	Jan.	10	1	57p.		18	4	2p.		25	9	47a.	Feb.	1	5	2a.
	Feb.	9	9	31a.		17	4	44a.		23	8	16p.	Mar.	2	10	8p.
	Mar.	11	3	21a.		18	2	19p.		25	6	37a.	Apr.	1	5	7p.
	Apr.	9	6	20p.		16	9	21p.		23	5	17p.	May	1	12	17p.
	May	9	6	20a.		16	2	47a.		23	4	57a.		31	6	4a.
	June	7	3	53p.		14	7	53a.		21	6	p.		29	9	41p.
	July	6	11	47p.		13	2	12p.		21	8	33a.		29	11	2a.
	Aug.	5	6	57a.		11	11	13p.		19	12	11a.		27	10	22p
	Sept.	3	2	21p.		10	12	noon		18	4	14p.		26	7	57a.
	Oct.	2	10	55p.		10	4	44a.		18	8	3a.		25	4	8p.
	Nov.	1	9	34a.		9	12	34a.		16	11	8p.		23	11	32p.
		30	10	51p.	Dec.	8	9	50p.		16	12	58p.		23	7	9a.
	Dec.	30	2	51p.												
1816					Jan.	7	6	41p.		14	1	18a.		21	4	13p.
	Jan.	29	8	50a.	Feb.	6	1	29p.		13	12	9p.		20	3	42a.
	Feb.	28	3	31a.	Mar.	7	4	55a.		13	9	47p.		20	5	41p.
	Mar.	28	9	27p.	Apr.	5	4	22p.		12	6	43a.		19	9	38a.
	Apr.	27	1	31p.	May	4	12	8a.		11	3	40p.		19	2	35a.
	May	27	3	7a.	June	3	5	18a.		10	1	19a.		17	7	48p.
	June	25	2	7p.	July	3	9	28a.		9	12	21p.		17	12	46p.
	July	24	11	9p.		31	2	25p.	Aug.	8	1	18a.		16	4	58a.
	Aug.	23	7	6a.		29	9	43p.	Sept.	6	4	22p.		14	7	47p.
	Sept.	21	3	3p.		28	8	25a.	Oct.	6	9	19a.		14	8	35a.
	Oct.	20	11	56p.		27	10	58p.	Nov.	5	3	18a.		12	7	8p.
	Nov.	19	10	23a.		26	5	6p.	Dec.	4	8	51p.		12	3	52a.
	Dec.	18	10	37p.		26	1	52p.								
1817									Jan.	3	12	44p.		10	11	42a.
	Jan.	17	12	38p.		25	11	43a.	Feb.	2	2	15a.		8	7	46p.
	Feb.	16	4	19a.		24	8	27a.	Mar.	3	1	35p.		10	4	53a.
	Mar.	17	9	11p.		26	2	2a.	Apr.	1	11	9p.		8	3	28p.
	Apr.	16	2	28p.		24	3	23p.	May	1	7	33a.		8	3	39a.
	May	16	7	a.		24	12	42a.		30	3	21p.	June	6	5	37p.

	NEW MOON				FIRST QUARTER				FULL MOON				LAST QUARTER			
Year.		day	h.	m.		day	h.	m.		day	h.	m.		day	h.	m.
1817	June	14	9	45p.		22	7	4a.		28	11	18p.	July	6	9	25a.
	July	14	10	17a.		21	11	56a.		28	8	22a.	Aug.	5	2	51a.
	Aug.	12	9	p.		19	4	50p.		26	7	36p.	Sept.	3	9	2p.
	Sept.	11	6	43a.		17	11	3p.		25	9	47a.	Oct.	3	2	42p.
	Oct.	10	4	15p.		17	7	44a.		25	2	55a.	Nov.	2	6	43a.
	Nov.	9	2	8a.		15	7	44p.		23	9	56p.	Dec.	1	8	21p.
	Dec.	8	12	33p.		15	11	29a.		23	4	59p.		31	7	33a.
1818																
	Jan.	6	11	36p.		14	6	44a.		22	10	26a.		29	4	42p.
	Feb.	5	11	38a.		13	4	2a.		21	1	29a.		27	12	27a.
	Mar.	7	12	59a.		15	1	8a.		22	2	1p.		29	7	37a.
	Apr.	5	3	44p.		13	7	51p.		20	12	13a.		27	3	4p.
	May	5	7	26a.		13	11	8a.		20	8	29a.		26	11	49p.
	June	3	11	13p.		11	10	51p.		18	3	28p.		25	10	46a.
	July	3	2	18p.		11	7	37a.		17	10	14p.		25	12	33a.
	Aug.	2	4	22a.		9	2	23p.		16	6	5a.		23	5	12p.
		31	5	28p.	Sept.	7	8	9p.		14	4	14p.		22	11	56a.
	Sept.	30	5	48p.	Oct.	7	2	5a.		14	5	29a.		22	7	30a.
	Oct.	29	5	28p.	Nov.	5	9	24a.		12	9	49p.		21	2	29a.
	Nov.	28	4	27a.	Dec.	4	7	19p.		12	4	19p.		20	7	32p.
	Dec.	27	2	52p.												
1819					Jan.	3	8	40a.		11	11	36a.		19	9	43a.
	Jan.	26	1	10a.	Feb.	2	1	24a.		10	6	15a.		17	8	39p.
	Feb.	24	11	53a.	Mar.	3	8	31p.		11	11	2p.		19	4	41a.
	Mar.	25	11	24p.	Apr.	2	4	19p.		10	1	5p.		17	10	47a.
	Apr.	24	11	48a.	May	2	11	13a.		9	12	6a.		16	4	17p.
	May	24	1	2a.	June	1	4	7a.		8	8	30a.		14	10	34p.
	June	22	3	1p.		30	6	28p.	July	7	3	20p.		14	6	53a.
	July	22	5	47a.		30	6	8a.	Aug.	5	9	57p.		12	6	13p.
	Aug.	20	9	13p.		28	3	27p.	Sept.	4	5	40a.		11	8	58a.
	Sept.	19	12	52p.		26	11	3p.	Oct.	3	3	22p.		11	2	57a.
	Oct.	19	3	55a.		26	5	54a.	Nov.	2	3	32a.		9	11	19p.
	Nov.	17	5	41p.		24	1	5p.	Dec.	1	6	11p.		9	8	29p.
	Dec.	17	5	53a.		23	9	44p.		31	11	6a.				
1820													Jan.	8	4	22p.
	Jan.	15	4	53p.		22	8	42a.		30	5	45a.	Feb.	7	9	14a.
	Feb.	14	3	16a.		20	10	14p.		29	12	52a.	Mar.	7	10	10p.
	Mar.	14	1	21p.		21	2	1p.		29	6	46p.	Apr.	6	7	24a.
	Apr.	12	11	14p.		20	7	22a.		28	9	55a.	May	5	1	50p.
	May	12	9	9a.		20	1	22a.		27	9	49p.	June	3	6	46p.
	June	10	7	40p.		18	7	1p.		26	7	4a.	July	2	11	37p.
	July	10	7	36a.		18	11	23a.		25	2	53p.	Aug.	1	5	50a
	Aug.	8	9	41p.		17	1	52a.		23	10	30p.		30	2	38p.
	Sept.	7	1	52p.		15	2	19p.		22	6	48a.		29	3	2a.
	Oct.	7	7	14a.		15	12	52p.		21	4	16p.		28	7	27p.
	Nov.	6	0	23a.		13	9	56a.		20	3	14a.		27	3	24p.
	Dec.	5	4	10p.		12	6	5p.		19	4	5p.		27	1	16p.
1821	Jan.	4	6	12a.		11	2	4a.		18	7	14a.		26	10	42a.
	Feb.	2	6	38p.		9	10	50a.		17	0	33a.		25	5	37a.

	NEW MOON				FIRST QUARTER				FULL MOON				LAST QUARTER			
Year.		day	h.	m.		day	h.	m.		day	h.	m.		day	h.	m.
1821	Mar.	4	5	37a.		10	9	7p.		18	6	53p.		26	8	50p.
	Apr.	2	3	11p.		9	9	24a.		17	0	31p.		25	8	10a.
	May	1	11	32p.		8	11	43p.		17	4	6a.		24	4	3p.
		31	7	22a.	June	7	3	44p.		15	5	14p.		22	9	30p.
		29	3	50p.	July	7	8	48a.		15	4	19a.		22	1	54a.
	July	29	2	12a.	Aug.	6	2	10a.		13	2	8p.		20	6	49a.
	Aug.	27	3	17p.	Sept.	4	7	7p.		11	11	21p.		18	1	49p.
	Sept.	26	7	6a.	Oct.	4	11	31a.		11	8	26a.		18	0	10a.
	Oct.	26	0	51a.	Nov.	3	1	13a.		9	5	50p.		16	2	35p.
	Nov.	24	7	16p.	Dec.	2	1	11p.		9	4	4a.		16	8	49a.
	Dec.	24	1	6p.		31	10	51p.								
1822									Jan.	7	3	46p.		15	5	38a.
	Jan.	23	5	25a.		30	6	49a.	Feb.	6	5	21a.		14	3	5a.
	Feb.	21	7	34p.		28	2	12p.	Mar.	7	8	34p.		15	11	18p.
	Mar.	23	7	8a.		29	10	4p.	Apr.	6	0	42p.		14	4	42p.
	Apr.	21	4	17p.		28	7	17a.	May	6	4	52a.		14	6	22a.
	May	20	11	42p.		27	6	20p.	June	4	8	23p.		12	4	15p.
	June	19	6	32a.		26	7	28a.	July	4	10	54a.		11	11	7p.
	July	18	2	1p.		25	10	47p.	Aug.	3	0	17a.		10	4	19a.
	Aug.	16	11	17p.		24	4	6p.	Sept.	1	0	26p.		8	9	30a.
	Sept.	15	11	2a.		23	10	50a.		30	11	27p.	Oct.	7	3	44p.
	Oct.	15	1	32a.		23	5	48a.		30	9	41a.	Nov.	6	0	37a.
	Nov.	13	6	36p.		21	11	24p.		28	7	42p.	Dec.	5	0	42p.
	Dec.	13	1	30p.		21	2	16p.		28	6	4a.				
1823													Jan.	4	4	10a.
	Jan.	12	8	54a.		20	2	0a.		26	5	11p.	Feb.	2	10	34p.
	Feb.	11	3	5a.		18	11	2a.		25	5	6a.	Mar.	4	6	48p.
	Mar.	12	6	34p.		19	6	18p.		26	5	41p.	Apr.	3	3	10p.
	Apr.	11	6	48a.		18	0	49a.		25	6	59a.	May	3	9	48a.
	May	10	4	13p.		17	7	32a.		24	9	7p.	June	2	1	22a.
	June	8	11	48p.		15	3	23p.		23	0	3p.	July	11	1	31p.
	July	8	6	40a.		15	1	21a.		23	3	28a.		30	10	50p.
	Aug.	6	1	53p.		13	2	20p.		21	6	41p.		29	6	17a.
	Sept.	4	10	19p.		12	6	45a.		20	9	1a.		27	0	56p.
	Oct.	4	8	41a.		12	2	6a.		19	10	11p.		26	7	44p.
	Nov.	2	9	40p.		10	10	52p.		18	10	21a.		25	3	33a.
	Dec.	2	1	36p.		10	6	56p.		17	9	50p.		24	1	18p.
1824	Jan.	1	8	7a.		9	0	36p.		16	8	50a.		23	1	46a.
	Jan.	31	3	48a.	Feb.	8	3	3a.		14	7	25p.		21	5	16p.
	Feb.	29	10	38p.	Mar.	8	2	10p.		15	5	37a.		22	11	11a.
	Mar.	30	3	2p.	Apr.	6	10	18p.		13	3	47p.		21	6	10a.
	Apr.	29	4	25a.	May	6	4	15a.		13	2	34a.		21	0	36a.
	May	28	3	3p.	June	4	9	10a.		11	2	38p.		19	5	21p.
	June	26	11	39p.	July	3	2	32p.		11	4	21a.		19	7	57a.
	July	26	7	9a.	Aug.	1	9	55p.		9	7	32p.		17	8	32p.
	Aug.	24	2	27p.		31	8	43a.	Sept.	8	11	39a.		16	7	16a.
	Sept.	22	10	27p.		29	11	32p.	Oct.	8	3	56a.		15	4	25p.
	Oct.	22	8	4a.		29	6	3p.	Nov.	5	7	43p.		14	0	19a.
	Nov.	20	8	1p.		28	2	56p.	Dec.	6	10	26a.		13	7	44a.

	NEW MOON				FIRST QUARTER				FULL MOON				LAST QUARTER			
Year.		day	h.	m.		day	h.	m.		day	h.	m.		day	h.	m.
1824	Dec.	20	10	40a.		28	0	18p.								
1825									Jan.	4	11	39p.		11	3	53p.
	Jan	19	3	43a.		27	8	24a.	Feb.	3	11	15a.		10	1	56a.
	Feb.	17	10	5p.		26	1	42a.	Mar.	4	9	21p.		11	2	26p.
	Mar.	19	4	23p.		27	3	10p.	Apr.	3	6	23a.		10	5	9a.
	Apr.	18	9	20a.		26	0	38a.	May	2	2	59p.		9	9	21p.
	May	18	0	6a.		25	6	52a.		31	11	58p.	June	8	2	18p.
	June	16	0	22p.		23	11	15a.		30	10	4a.	July	8	7	24a.
	July	15	10	25p.		22	3	34p.		29	9	57p.	Aug.	7	0	24a.
	Aug.	14	6	58a.		20	9	34p.		28	Noon.		Sept.	5	4	8p.
	Sept.	12	3	0p.		19	6	29a.		27	4	13a.	Oct.	5	6	22a.
	Oct.	11	11	30p.		18	7	6p.		26	10	2p.	Nov.	3	6	22p.
	Nov.	10	9	14a.		17	11	31a.		25	4	12p.	Dec.	3	4	8a.
	Dec.	9	8	35p.		17	7	6a.		25	9	13a.				
1826													Jan.	1	0	21p.
	Jan.	8	9	39a.		16	4	38a.		24	0	2a.		30	8	9p.
	Feb.	7	0	22a.		15	2	11a.		22	0	25p.	Mar.	1	4	31a.
	Mar.	8	4	30p.		16	9	30p.		23	10	42p.		30	2	3p.
	Apr.	7	9	27a.		15	0	58p.		22	7	34a.		29	1	3a.
	May	7	2	17a.		15	0	12a.		21	3	17p.		28	1	46p.
	June	5	5	55p.		13	7	55a.		19	10	54p.		27	4	26a.
	July	5	7	36a.		12	1	24p.		19	7	13a.		26	9	4p.
	Aug.	3	7	21p.		10	6	14p.		17	5	14p.		25	3	9p.
	Sept.	2	5	42a.		8	11	45p.		16	5	57a.		24	9	32a.
	Oct.	1	3	29p.		8	7	10a.		5	9	46p.		24	2	50a.
		31	1	22a.	Nov.	6	5	25p.		14	4	9p.		22	5	59p.
	Nov.	29	11	37a.	Dec.	6	7	13a.		11	11	31a.		22	6	35a.
	Dec.	28	10	31p.												
1827					Jan.	5	0	43a.		13	6	2a.		20	4	48p.
	Jan.	27	9	46a.	Feb.	3	9	6p.		11	10	23p.		19	1	10a.
	Feb.	25	10	14p.	Mar.	5	6	27p.		13	0	9p.		20	8	23a.
	Mar.	27	0	2p.	Apr.	4	2	25p.		11	11	23p.		18	3	19p.
	Apr.	26	3	2a.	May	4	7	25a.		11	8	25a.		17	10	59p.
	May	25	6	40p.	June	2	8	53p.		9	3	50p.		16	8	27a.
	June	24	10	4a.	July	2	7	8a.		8	10	30p.		15	8	35p.
	July	24	0	44a.		31	2	59p.	Aug.	7	5	40a.		14	11	48a.
	Aug.	22	2	31p.		29	9	21p.	Sept.	5	2	36p.		13	5	44a.
	Sept.	21	3	31a.		28	3	14a.	Oct.	5	2	19a.		13	1	17a.
	Oct.	20	3	47p.		27	9	48a.	Nov.	3	5	14p.		11	8	59p.
	Nov.	19	3	19a.		25	6	18p.	Dec.	3	10	51a.		11	3	23p.
	Dec.	18	2	5p.		25	5	48a.								
1828									Jan.	2	5	56a.		9	7	15a.
	Jan.	17	0	24a.		23	8	45p.	Feb.	1	1	4a.		8	7	55p.
	Feb.	15	10	45a.		22	2	39p.	Mar.	1	6	52p.		9	5	18a.
	Mar.	15	9	38p.		23	10	2a.		31	10	18a.	Apr.	7	0	6p.
	Apr.	14	9	18a.		22	5	18a.		29	10	44p.	May	6	5	32p.
	May	13	9	50p.		21	11	11p.		29	8	17a.	June	4	11	2p.
	June	12	11	12a.		20	2	52p.		27	3	43p.	July	4	6	1a.
	July	12	1	29a.		20	4	3a.		26	10	19p.	Aug.	2	3	38p.

	NEW MOON				FIRST QUARTER				FULL MOON				LAST QUARTER			
Year.		day	h.	m.		day	h.	m.		day	h.	m.		day	h.	m.
1828	Aug.	10	4	42p.		18	2	46p.		25	5	28a.	Sept.	1	4	38a.
	Sept.	9	8	34a.		16	11	27p.		23	2	13p.		30	9	7p.
	Oct.	9	0	18a.		16	6	47a.		23	1	12a.		30	4	34p.
	Nov.	7	3	4p.		14	1	49p.		21	2	40p.		29	1	45p.
	Dec.	7	4	I5a.		13	9	39p.		21	6	29a.		29	10	41a.
1829																
	Jan	5	3	52p.		12	7	18a.		20	0	17a.		28	5	21a.
	Feb.	4	2	31a.		10	7	23p.		18	7	15p.		26	8	20p.
	Mar.	5	0	36p.		12	9	49a.		20	1	51p.		28	7	19a.
	Apr.	3	10	21p.		11	2	7a.		19	6	22a.		26	2	55p.
	May	3	7	57a.		10	7	36p.		18	7	48p.		2.5	8	19p.
	June	1	5	49p.		9	1	23p.		17	6	15a.		24	0	57a.
	July	1	4	45a.		9	6	31a.		16	2	42p.		23	6	14a.
		30	5	39p.	Aug.	7	11	13p.		14	10	26p.		21	1	35p.
		29	8	55a.	Sept.	6	noon.			13	6	29a.		20	0	6a.
	Sept.	28	3	3a.	Oct.	5	1	49p.		12	3	29p.		19	2	30p.
	Oct.	27	7	44p.	Nov.	4	9	51a.		11	1	46a.		18	8	51a.
	Nov.	26	0	32p.	Dec.	3	6	33p.		10	1	38p.		18	6	4a.
	Dec.	26	3	36a.												
1830					Jan.	2	2	34a.		9	3	32a.		17	4	3a.
	Jan.	24	4	54p.		31	10	47a.	Feb.	7	7	42p.		16	0	28a.
	Feb.	23	4	36a.	Mar.	1	8	2p.		9	1	31p.		17	5	36p.
	Mar.	24	2	44p.		31	6	58a.	Apr.	8	7	29a.		16	6	49a.
	Apr.	22	11	27p.		29	7	54p.	May	8	0	2a.		15	4	18p.
	May	22	7	13a.		29	10	48a.	June	6	2	19p.		13	10	49p.
	June	20	3	3p.		28	3	16a.	July	6	2	24a.		13	3	36a.
	July	20	0	14a.		27	8	36p.	Aug.	4	0	57p.		11	8	8a.
	Aug.	18	11	53a.		26	2	3p.	Sept.	2	10	38p.		9	1	58p.
	Sept.	17	2	28a.		25	6	52a.	Oct.	2	7	57a.		8	10	32p.
	Oct.	16	7	31p.		24	10	20p.		31	5	18p.	Nov.	7	15	53a.
	Nov.	15	1	55p.		23	11	44a.		30	3	8a.	Dec.	7	3	16a.
	Dec.	15	8	19a.		22	10	42p.		29	2	2p				

NOTE. A scheme of the weather has been for some years in circulation under the title of **Herschel's Table** (disclaimed however by the celebrated astronomer of that name) in which the changes are made to depend in great measure on the hour of day or night at which the moon enters upon her several phases — **noon** being the point most likely to be followed by rain and **midnight** most favourable to fair weather: the meridian for which it is calculated not expressed. This scheme is empirical and its media consequently very dubious — but the reader who may possess and incline to examine it, as for London may do this by comparing (as I have done) the times of the Lunations as here stated with the Rain column and Notes in my Tables; referring to the scheme as he proceeds. It appears to me that the approximation of the time of the moon's change to noon or midnight may very well be placed **among the elements of the problem** of the weather for a given season; but not made a general rule of. [1st. Edit. 1820.]

1833. The Table above mentioned being very short. I shall here annex a copy of the scheme, or the directions which it contains:

Time of Change		IN SUMMER	IN WINTER
At Noon		Very Rainy	Snow or Rain
Between	2 and 4 p.m.	Changeable	Fair and Mild
	4 and 6 p.m.	Fair	Fair
	6 and 8 p.m.	Fair, in Wind is NW	Fair and frosty, N or NE
		Rainy if S or SW	Rain or Snow if S or W
	8 and 10 p.m.	Ditto	Ditto
	10 and Midnight	Fair	Fair and Frosty
	Midnight and 2 a.m.	Fair	Hard Frost, unless wind S or W
	2 and 4 a.m.	Cold, with frequent showers	Snow, and Stormy
	4 and 6 a.m.	Rain	Ditto
	6 and 8 a.m.	Wind and Rain	Stormy
	8 and 10 a.m.	Changeable	Cols Rain if Wind W. Snow if E.
	10 and Noon.	Frequent Showers	Cols, with high wind.

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END OF THE FIRST VOLUME