This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

A MANUAL
OF
THE THERMOMETER;
CONTAINING ITS HISTORY AND USE AS
A METEOROLOGICAL INSTRUMENT.

TO WHICH IS ADDED,

AN ESSAY ON THE
VAPOUR-POINT AND TERRESTRIAL RADIATION:

ALSO,

A GENERAL OUTLINE OF THE
CLIMATE OF THE EASTERN PART OF ENGLAND.

BY JOHN HENRY BELVILLE,
OF THE ROYAL OBSERVATORY, GREENWICH.

"He hath given them a law, which shall not be broken."—*Psalm* 48. v. 6.

LONDON:
RICHARD AND JOHN EDWARD TAYLOR,
RED LION COURT, FLEET STREET.
1850.

PRINTED BY RICHARD AND JOHN E. TAYLOR,
RED LION COURT, FLEET STREET.

PREFACE.

HAVING entered in the year 1811 on duties at the Royal Observatory, which required attendance not only by day but also by night, my attention was necessarily very early directed to the great changes to which the climate of England is susceptible: the sudden formation and disappearance of the clouds, the great variations of temperature, the unsteadiness of the mercurial column, and its connexion with the different winds which blow, became subjects of interest, and were tabulated day by day until they have now accumulated into a mass of observation from which much valuable information is to be deduced. In a treatise so small as that comprehended in the following pages, a few only of the leading features of the climate can be discussed. Terrestrial radiation and the vapour-point have been spoken of at some length, as they are less popular, and their laws less understood than those of temperature in general. The Tables of Climate at the end of the work are deduced from above 21,000 observations, and are now published for the first time. Tables of barometric pressure and the average amount of rain for the corresponding period have already appeared in my lately-published little treatise, the "Manual of the Barometer."

J. H. B.

Hyde Vale, March 1850.

CONTENTS.

Page

PREFACE iii

On the Thermometer: its history and construction; description of Sixe's, Rutherford's, differential, &c.; best manner of placing instrument for meteorological observations.................................... 1–10

Comparison of Fahrenheit's Thermometer with the Centigrade and Reaumur 11

Table showing elevations by the temperature at which water boils 12

On the Dew-point: observations and general laws 12–20

On the Clouds: nomenclature, formation, &c.......................... 21–24

On Terrestrial Radiation: experiments, series of observations; state of atmosphere favourable to radiation; effects on vegetation; cause of dew 24–32

Decrease of Temperature in Atmosphere 32

Difference of Climate in the Eastern and Western parts of England 32–34

Climate of the Eastern parts of England: Winter, Spring, Summer, Autumn, &c. 34–49

Table of Mean Temperatures for every day of the year 50

Table of Mean Temperatures of the Seasons from 1815 to 1849 52

Table of greatest and least observed Heights of the Thermometer from 1807 to 1849 53

Table of the Mean of the Maxima and Minima Temperatures for every month 54

A Synoptical Table of Mean Temperatures, Dew-points, &c. ... 56

ON

THE THERMOMETER.

THE Thermometer, by which we measure the changes of temperature in bodies, is an instrument so simple and familiar, that we are apt to overlook the difficulties which were to be overcome before it was brought to its present perfect state; the list of distinguished names, which succeed each other in the endeavour to contribute something towards its perfection, convince us, it was not only a work of intellectual labour, but that it was an instrument of importance in philosophical inquiry. About the beginning of the 17th century, Drebbel of Alkmaer is said to have made thermometers; but Sanctorio, a professor of Padua, who lived about the same period, claims the merit of the invention, and his claim is supported by Borelli and Malpighi. Sanctorio's thermometer consisted of a glass tube, having a bulb blown at one extremity, the air in which being rarefied, the open end was plunged into a coloured liquid; as the air cooled it contracted its volume, and a part of the liquid rose in the tube; as the temperature of the tube increased or diminished, the air in the bulb expanded or contracted, and the liquid in the tube descended or ascended.

The expansions of the air were measured by a scale, the measurements of which varying, independently of the temperature, with every change of pressure in the atmosphere, rendered its indications very erroneous. Some years subsequently, the Florentine Academicians excluded all the air from the tube, and filling it to a certain height with spirits of wine, sealed the tube hermetically. Boyle, in England, made numerous experiments with tubes both open and sealed, and found that the former were affected by the changes in the pressure of the atmosphere, to the amount in some cases of 33 divisions of the scale. In 1701 Sir Isaac Newton filled the tube with linseed oil, but its viscidity caused it to adhere to the sides of the tube; and in 1702 Amontons again tried air, for which in 1703 he substituted spirits of wine; which were also used by Reaumur and Michelli in 1730 and 1740; in 1724 Fahrenheit filled the tube with mercury, as did also De Lisle in 1733.

At a later period De Luc made very careful comparisons of the different ratios of condensation in oil, spirits of wine, and mercury, and was so satisfied that the latter fluid possessed, in the highest degree, the properties essential for the correct indication of changes of temperature, that he filled the tube with mercury, adopting at the same time the scale of Reaumur. The advantages of mercury were, that it expanded *equably*, and therefore measured equal increments and decrements of heat; it could be obtained in a nearly pure state, it was easily freed from air, and it did not become solid until exposed to a cold of —39° Fahr., or vaporize until it attained a heat of 660°. Spirits of wine vaporize at 180°, so that at higher temperatures the elastic force of the vapour, increasing with the increasing temperature, exerts an increasing pressure upon the fluid, and the expansions become gradually smaller for each equal increase of heat; spirits of wine are adapted for low temperatures, a cold of −90° having failed to reduce it to the solid state.

Another difficulty which presented itself in the construction of the Thermometer, was the adoption of a fixed point of temperature from which to commence the divisions of its scale. Newton was the first to suggest the discoveries of Dr. Hook as the means of furnishing two fixed points, which might be universally used; the temperature of water, in passing from the liquid to the solid state, remains stationary; and the temperature of water, in passing from the liquid into the gaseous state, likewise remains stationary, provided, in the latter case, the pressure of the atmosphere be the same: if these two points of temperature, the freezing and boiling of water, were marked upon the tube, the interval between them might be divided at pleasure, and divisions of the same length continued above and below these points, as the length of the tube might admit. Reaumur and Celsius adopted the freezing of water as a *zero*; the former divided the interval between that and the boiling-point into 80 parts or degrees, the latter divided it into 100. Fahrenheit made his *zero* the temperature produced by the mixture of snow and common salt; he divided the interval between that and the freezing-point of water into 32 parts, and the interval between the freezing- and boiling-points of water into 180 parts; other divisions of the scale have been made, but those of Reaumur, Celsius (or Centigrade) Fahrenheit, have been universally adopted.

The tube of the thermometer being too narrow to admit of the mercury being poured in, the air within it is rarefied, and the mercury forced into it (upon the principle of the Barometer) by the pressure of the atmosphere. The bulb is held over the flame of a spirit-lamp, and as the air within it becomes heated, it expands, so that the quantity left in bears a small proportion to that which it had contained at the temperature of the atmosphere; the tube is then inverted, and the open end plunged into a vessel of pure mercury; as the air within the tube cools down to the temperature of the air, it contracts, and occupies a smaller space, and the pressure of the atmosphere on the surface of the mercury in the vessel forces it into the tube; the tube is again inverted, and the bulb again held over the flame of the lamp, the small quantity of air remaining within expands, and is forced out of the tube; the bulb is exposed to the heat until the mercury boil, the vapour of which, filling the unoccupied part of the bulb and tube, will altogether expel the air; the open end is again plunged into the vessel of mercury, and the pressure of the atmosphere forces mercury into the tube and bulb until they be filled; the tube is then closed by melting the glass with the blowpipe: if the vacuum be perfect, on inverting the instrument, the mercury will run to the top of the tube and fill it: the quantity of mercury depends upon the capacity of the tube to the bulb: that the thermometer may show equal expansions and contractions, the bore of the tube must be uniform throughout its length.

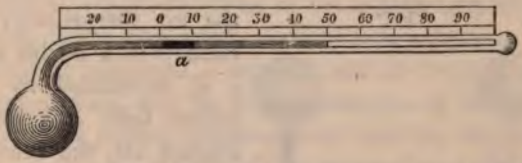
To mark off the freezing-point, the thermometer must be plunged into a vessel of melting snow or pounded ice, either of which will retain the same temperature, until they be all melted: to mark off the boiling-point, it must be plunged into a vessel of rain or distilled water, which when it boils will not increase in temperature, but will remain stationary, until it all fly off in steam: in this latter case the pressure on the surface of the water will have some effect; if the pressure be increased, it will boil at a higher temperature; if it be diminished, it will boil at a lower; it must therefore be always done at one fixed pressure: the pressure recommended by the Royal Society, is when the barometer stands at 29·80 inches. The divisions below which the numeration commences, are called negative, and marked thus —

Fig. 1.

Thermometers now spoke a general language, and scientific men in different countries were enabled to compare, with confidence, their several experiments upon the effects of changes of temperature upon bodies: still there were cases in which it was desirable to know the greatest, and least fluctuations of temperature during the absence of the observer; this was especially necessary for ascertaining the extremes of temperature which might occur in the atmosphere: in 1782 Mr. J. Sixe of Canterbury contrived an instrument which should record these changes. In fig. 1, *a* is a tube of glass joined at *b* to a smaller tube *e h*, which is bent downwards, and at about 1½ inch from below the end *d*, is again bent upwards in the direction *i f*, parallel to *h e*, the end *c* of the smaller tube being enlarged. These tubes, with the exception of that part of the small tube from *h* to *i* which is filled with mercury, are filled with highly rectified spirits of wine, to within an inch of the enlarged end *c*; when the spirit in the large tube *a* is expanded by heat, the surface of the mercury at *h* will be pressed down, and consequently the surface at *i* will rise; and when the spirit is contracted by cold, the mercury at *h* will rise and the surface at *i* will fall; so that whenever the spirit is either expanded or contracted by a change of temperature, the mercury on one side or the other will always rise. The scale, which is Fahrenheit's, beginning with 0 on the top of that side *h e* where the mercury rises by the increase of cold, has the degrees numbered downwards; while that on the opposite side *i f*, where the mercury rises by the increase of heat, has the degrees numbered upwards. Within the small tube of the thermometer immersed in the spirits, is placed on either side above the surface of the mercury, a small index *e f*, so fitted as to be moved up and down as occasion may require; the surface of the mercury when it rises, carries this index with it, which when the mercury descends remains fixed, by means of a spring, and shows how high it had risen, and consequently the greatest degrees of heat and cold. The index is made of steel coated with glass, and terminated with a dot of enamel on each end; from the end of the index, to prevent its moving by its own weight, is attached a bristle (formerly a spring of glass was used), which prevents the index from following the mercury when it descends; it is brought into contact with the mercury by a small magnet being applied to that part of the tube against which it rests.

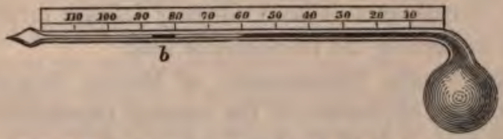
A Self-registering Thermometer of simpler construction, by Dr. John Rutherford of Edinburgh, is now in general use. In fig. 2, the minimum or lowest temperature is shown by a spirit thermometer, in which is placed an index, *a*, of enamel; the cohesive power of the spirit in the tube prevents the enamel from passing it, and it is carried back to the lowest point of contraction, and being left there, marks the greatest degree of cold; it is adjusted by inverting the instrument, when the index runs up to the end of the column of the spirit where it stops. It is preferable for the *minimum* thermometer to be graduated on its own tube.

Fig. 2.



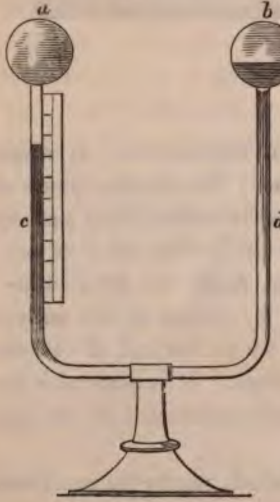
In the thermometer, fig 3, which marks the *maximum* or highest temperature, the index *b*, which is of steel, is pushed up by the mercury and left at the point of greatest expansion; the index is afterwards brought in contact with the mercury by a magnet.

Fig. 3.



Mechanical contrivances have been made, for the thermometer to register continuously the changes in the atmospheric temperature; the latest experiment is the application of photography, aided by clockwork.

Fig. 4.



The Differential Thermometer, fig. 4, of Sir John Leslie, is a modification of the air thermometer; it consists of a double stem *c d*, terminated by two hollow balls *a b*, which contain air, the intermediate stems *c d* holding sulphuric acid tinged with carmine: when the balls are of the same temperature the liquor will remain stationary; but if one of the balls be warmer than the other, the liquor, urged by the increased elasticity of the air, will descend proportionally on that side; the interval between the freezing- and boiling-points is divided into 1000 parts. This thermometer is used for very delicate investigations concerning the properties of heat.

The Metallic Thermometer, of Messrs. Breguet of Paris, is an application of the unequal expansibility of two metals; it is of the form and size of a watch: the expanding metallic bar forms a double curve, composed of two laminæ of steel and brass firmly united; the excess of the expansion of the brass, above the steel, causing the curve to expand and contract, which acts upon a lever, the opposite and longer arm of which consists of an arch-head, with fine teeth upon its edge, which act upon a small pinion, upon the axis of which the needle which traverses the dial is fixed.

The knowledge of the effects of temperature on metallic substances has led to the application of two metals, of different expansive power, in the construction of the balance of the chronometer; by which assistance the instrument maintains a uniform rate in every change of temperature, and has thus become one of the most delicate and perfect machines ever made by the hand of man. The *chronometrical* thermometer resembles the marine chronometer in all respects, but in the compensation of the balance; in the latter, the two metals are so applied as to *destroy* all the errors arising from a change of temperature; in the former, they are applied to *double* all the errors: if the chronometrical thermometer be adjusted to keep mean time at 60° of Fahrenheit, if the temperature rise above 60°, it will daily lose minutes in proportion to the increase of heat; if the temperature fall below 60°, it will gain minutes in proportion to the decrease of heat.

The thermometer is indispensable in every physical and scientific investigation; popularly it measures the heights of mountains, the pressure of steam, and imparts a knowledge of the temperature of the globe; it measures the cold from radiation and evaporation, and by covering the bulb of a second instrument with muslin and moistening it with water, it becomes an hygrometer and weighs the amount of vapour in the atmosphere. The thermometer, as a meteorological instrument, requires much caution in the selection of a situation for it; it must be placed *absolutely* in the shade, and as far away as possible from the influence of heat *reflected* from walls and buildings; the bulb must be protected from the rain and kept perfectly *dry*, to prevent the temperature from standing too low, from the effects of evaporation; a post driven into the ground a few feet from the *north* wall of a house (or a stand), with a bracket and hood, against the back of which the thermometer may be fixed, is convenient; the same caution applies to the placing the register thermometers, and the minimum should be so fixed that one side of it may be easily unhooked, to allow the index to return to the extremity of the fluid: the thermometer for ascertaining the temperature on the surface of the ground should be graduated on its own tube, and placed away from shrubs or trees, so that it may be perfectly *open to the sky*: the wet- and dry-bulb thermometer must also be sheltered from the sun's rays, from reflexion, and from rain; the covered bulb must be kept moist, and in frosty weather wetted a quarter of an hour previously to the observation being taken. The periods of the day best suited for hygrometric observations are 9 A.M., 3 P.M., and 9 P.M.; the standard thermometer should be read off at the same hours; the registers for the *maximum* and *minimum* temperature should be read off early, and the indices restored at the same time to their places. The observations should be read off quickly, more particularly in cold weather; the observer should be careful neither to touch or *breathe*, or indeed approach the body too closely to the instruments; the eye should be placed on a level with the mercury, and *accuracy* should be the animus of observation.

Comparison of Fahrenheit's Thermometer with the Centigrade, and Reaumur's.

Fahr.	Centigrade.	Reaumur.	Fahr.	Centigrade.	Reaumur.	Fahr.	Centigrade.	Reaumur.
−1°	−18°·4	−14°·7	33°	+0°·6	+0°·4	67°	+19°·4	+15°·6
0	17·8	14·2	34	0·1	0·9	68	20·0	16·0
+1	17·2	13·8	35	1·7	1·3	69	20·6	16·4
2	16·7	13·3	36	2·2	1·8	70	21·1	16·9
3	16·1	12·9	37	2·8	2·2	71	21·7	17·3
4	15·6	12·4	38	3·3	2·7	72	22·2	17·8
5	15·0	12·0	39	3·9	3·1	73	22·8	18·2
6	14·4	11·6	40	4·4	3·6	74	23·3	18·7
7	13·9	11·1	41	5·0	4·0	75	23·9	19·1
8	13·3	10·7	42	5·6	4·4	76	24·4	19·6
9	12·8	10·2	43	6·1	4·9	77	25·0	20·0
10	12·2	9·8	44	6·7	5·3	78	25·6	20·4
11	11·7	9·3	45	7·2	5·8	79	26·1	20·9
12	11·1	8·9	46	7·7	6·2	80	26·7	21·3
13	10·6	8·4	47	8·3	6·7	81	27·2	21·8
14	10·0	8·0	48	8·9	7·1	82	27·8	22·2
15	9·4	7·6	49	9·4	7·6	83	28·3	22·7
16	8·9	7·1	50	10·0	8·0	84	28·9	23·1
17	8·3	6·7	51	10·6	8·4	85	29·4	23·6
18	7·8	6·2	52	11·1	8·9	86	30·0	24·0
19	7·2	5·8	53	11·7	9·3	87	30·6	24·4
20	6·7	5·3	54	12·2	9·8	88	31·1	24·9
21	6·1	4·9	55	12·8	10·2	89	31·7	25·3
22	5·6	4·4	56	13·3	10·7	90	32·2	25·8
23	5·0	4·0	57	13·9	11·1	91	32·8	26·2
24	4·4	3·6	58	14·4	11·6	92	33·3	26·7
25	3·9	3·1	59	15·0	12·0	93	33·9	27·1
26	3·3	2·7	60	15·6	12·4	94	34·4	27·6
27	2·8	2·2	61	16·1	12·9	95	35·0	28 0
28	2·2	1·8	62	16·7	13·3	96	35·6	28·4
29	1·7	1·3	63	17·2	13·8	97	36·1	28·9
30	1·1	0·9	64	17·8	14·2	98	36·7	29·3
31	− 0·6	− 0·4	65	18·3	14·7	99	37·2	29·8
32	0·0	0·0	66	+18·8	+15·1	100	+37·8	+30·2

To convert degrees of Centigrade into corresponding degrees of Fahr., multiply by 9, divide by 5, and *add* 32° to the result.

When the temperature of Centigrade is *below* 0, multiply by 9, divide by 5, and *subtract* the result from 32°.

To convert degrees of Reaumur into corresponding degrees of Fahr., multiply by 9, divide by 4, and *add* 32° to the result.

When the temperature of Reaumur is *below* 0, multiply by 9, divide by 4, and *subtract* the result from 32°.

A Table showing elevations in feet, and the corresponding temperatures at which water boils at those elevations; the pressure at the level of the sea being 30·0 *in.*

Elevation above the level of the sea in feet.	Heat of boiling water.	Elevation above the level of the sea in feet.	Heat of boiling water.
	212°·0	3,926	204°·9
462	211·1	4,460	204·0
933	210·0	5,000	203·0
1411	209·3	6,111	201·2
1897	208·5	7,263	200·0
2392	207·6	13,700	190·0
2895	206·7	18,000	180·0
3407	205·8	26,000	170·0

At Potosi, water boils at 190°.
At Mexico, water boils at 200°.
On the summit of Ben Nevis, at 205°.
On the summit of Snowdon, at 206°.

On the Dew-point, Clouds, and Terrestrial Radiation.

The influence of climate on the health of man invests meteorology with interests which have at length awakened attention; meteorology has been hitherto very lowly estimated, for its laws were only to be deduced from observation, and the difficulty of catching the phænomena of Nature *exactly* in the same combination made their deduction so tedious a process, that the task necessarily devolved upon the patient and unassuming, who observed, tabulated and accumulated a store of valuable data. From these data, the point of past experience, we are now compelled to start on our future investigations; for assiduous as we may be in our attendance on Nature, she will not alter her seasons, develope her phænomena, or unfold her secrets more expeditiously to our inquiries than to those of her votaries of past years: observations may be multiplied, their results tortured into every variety of combination, quantity may compensate instrumental errors, but no power of numbers can elicit a substitute for *time*; the industry and genius of bygone years are entitled to acknowledgement, and we should remember as we verify and correct their labours, that to them we are indebted for the foundation upon which we are raising a superstructure. Accuracy is essential in an observer of meteorological phænomena; the enthusiasm of youth is apt to find Nature changing her order, and presenting anomalies which zeal registers and self-love defends; the caution of age suffers phænomena to disappear before its doubts are solved; an observer to be valuable must be trained by graver experience, and taught to curb the flights of imagination, to restrain the flow of eloquence, and to follow Nature in all her wonderful regularity; he must be taught that talent and profound penetration are granted to few, but that brevity, modesty and truth are within the attainment of all.

A knowledge of the meteorological conditions which constitute the diversities of climate is highly necessary to the horticulturist, more especially in a country like England, in which there is scarcely a production which is indigenous to it. Of the distinguished men of the present generation who have endeavoured to render this knowledge popular, Humboldt stands pre-eminent; he lays aside his formulæ, and in describing the various countries he has visited, he enumerates the several productions of their different regions, and paints in such glowing language the phænomena of their varied climates, that as we read we feel oppressed with the cloudless skies, and tremble with terror as the thunder roars and the restless volcano shakes the stability of the earth; he leads us over the mighty mountains of the western world, where he displays as we ascend the altered character of vegetation, invites the recognition of plants familiar to our temperate land, and points to the cold and cheerless spot where Nature ceases to cover the rock with even the smallest lichen of the icy north; and when he has shown these wonders, the produce of a hemisphere beneath the torrid zone, his comprehensive mind unfolds how all this charming diversity has sprung from the *distribution of heat*: animated by his enthusiasm, untired we pursue, while he relates that lands unlike in latitude have equal quantities of heat, and that it is the different distribution of this heat throughout the seasons of the year, assisted by geographical position, which gives rise to diversities of climate, and calls forth a life and vegetation suited to those conditions only: and then he tells of cold around the pole of long continuance, and so intense, that rarely is there heat enough to render water fluid: we mark with him the falling temperature as he ascends the atmosphere; we note the effect of heat in raising vapour from the earth; we watch it passing into clouds, which intercept the solar heat by day, and rob the earth of dew by night, and which when grown too dense and heavy to be supported by the atmosphere we see descend in genial rains; until the mind excited longs to know the cause of these phænomena, and turns with pleasure to the works of those philosophers which explain them.

The experiments of Dalton teach, that heat by the process of evaporation converts the waters of the globe into aqueous vapour, which is diffused throughout the atmosphere; they teach that under a pressure of the atmosphere of thirty inches the temperature of water when it boils is 212°, and that then it flies off in steam or vapour: by the air-pump Dalton diminished the pressure of the atmosphere upon water, and noted down in the following table the temperatures at which it boiled as he withdrew the pressure:—

Pressure upon the surface of water in inches of mercury.	Heat of the water when boiling.
30 00	212°
22·80	200
18·60	190
15·20	180
12·20	170
9·45	160
7·48	150
5·85	140
4·42	130
3·27	120
2·52	110
1·97	100
1·47	90
1·00	80

These were the experiments, upon which he based his data, for learning the amount of vapour which can exist at any given temperature in the atmosphere. From him we learn that vapour is elastic, and that its *greatest elasticity*, or *force*, or *tension*, equals the *pressure* of the atmosphere, under which water boils at the temperature of the vapour*. If the temperature of the atmosphere were 80°, and a cubic foot of it were *filled* or *saturated* with vapour, the vapour also would have a temperature of 80°; at 80° water boils under a pressure of 1·00 inch, therefore the elasticity of the vapour in that cubic foot of air would equal 1·00 inch, and it would raise the mercurial column to that amount; but if, the temperature still remaining 80°, more vapour were forced into the cubic foot of air, instead of its increasing the elasticity of that already there, it would collapse and fall in moisture; but should the temperature rise to 90°, the elasticity would increase until it were equal to 1·47 inch.

The atmosphere being able to contain *more* vapour as its temperature *increases*, heat is necessarily a promoter of evaporation: the ardent heat of the torrid zone evaporates a large amount of vapour, which falls in rains so copious that the inhabitant of northern lands fancies it must be a fable, that an hour produces a quantity distributed in his colder climate over a period of many months; the lesser heat of the temperate zones imbibes less vapour, and the rains are moderate; and the cold of the Polar regions reduces so much the amount of vapour, that its precipitation cannot exceed a few inches: the actual capacities of the three zones for imbibing vapour, measured in their greatest elastic force, their mean heat being severally estimated at 82°, 55°, and 34°, is 1·07 inch, 0·442 inch, and 0·214 inch. These numbers representing the saturation of a given space (a cubic foot)

---

* When water boils at 180° the temperature of the vapour is 180°, and its greatest elasticity is equal to 15·00 in.

When water boils at 212° the temperature of the vapour is 212°, and its greatest elasticity is equal to 30·00 in.

When water boils at 244° the temperature of the vapour is 244°, and its greatest elasticity is equal to 60·00 in.

of the atmosphere, do not signify that the *actual moisture* of the three zones is always in these proportions, for there is no doubt but that the temperate zones, lying between the extremes of heat and cold, and meeting midway the equatorial and polar currents, have the atmosphere most frequently saturated with vapour; the winds blowing from the warmer regions waft strata of the air of a higher temperature into those of a lower, and the vapour with which the former are laden becomes condensed and suspended in clouds, or it falls in rain, &c.; on the contrary, the winds from the cold regions waft strata of the air of a lower temperature into those of a warmer, and the vapour in these latter becomes likewise condensed, and likewise visible as clouds, or fall in rain, snow, &c.

Wind accelerates evaporation; during a warm day evaporation may be brisk, but if a gentle breeze spring up it is much quicker; "for the air which receives the vapour, being carried away by the movement of the wind, other and drier particles of air are brought in contact with the evaporating surface, and they in like manner imbibe moisture, and are in their turn carried off*:" the vapour being thus removed as soon as formed, the air relatively to temperature remains dry, while the rapid evaporation produces an agreeable and refreshing coolness: as the heat of the day diminishes, the air appears more filled with vapour; and as evening advances, and the cold increases, and the wind grows calm, the vapour is seen floating in the atmosphere, and eventually covering with moisture every object with which it comes in contact: during these changes the *quantity* of vapour has *not* increased as evening has advanced, but as the temperature of the air

---

* Heat and Moisture, Sir J. Leslie.

has fallen, the vapour in it has been gradually condensing, until having attained a maximum of elasticity, a further reduction of the heat has necessarily produced a diminished elasticity, and the overplus of vapour, which the diminished temperature of the air could not sustain, has been deposited in moisture.

As the atmosphere is not always saturated with vapour, it became a subject of interest to ascertain how much it *actually* did contain at any given time; and we are indebted to Dalton for the solution of this problem. The greatest elasticity of vapour was known for every degree of temperature, and if the vapour in the air could be brought to its greatest tension, its quantity might then be ascertained. "He took a glass vessel, into which he poured cold water, the temperature of which, when necessary, he reduced by cooling mixtures; he then watched it attentively until he observed a deposition of moisture on the *exterior* surface of the glass; after which he examined the temperature of the water, and assumed it as the temperature of the greatest elasticity of the vapour, or the point at which it would be just retained in a state of vapour." The water in the glass being colder than the air around it, cooled down those particles in contact with it, until they had so far overcome the elasticity of the vapour contained between them, as to force it to deposit itself as dew upon the outer surface of the glass; the temperature at which this deposition occurred was called the dew-point: referring to a table of the elasticities of vapour*, under that temperature we find the elasticity of the vapour contained in the air, measured in the height of the mercurial column it can support, and this being known, Gay-Lussac, a French

---

* For easy rules and tables for the use of the wet- and dry-bulb thermometer see 'Manual of Barometer,' page 34, 2nd edition.

philosopher, has given a formula for finding the *weight* of the vapour in the air.

The following table, deduced from seven years' observation of the dew-point at Greenwich, shows the mean elasticity *of vapour in the atmosphere at* 9 A.M. *and* 3 P.M. *for every month of the year, measured in the height of the mercurial column it supports; it also shows the mean* weight *in grains of vapour in a cubic foot of air, and the mean additional weight of vapour required for the complete saturation of a cubic foot of air, and the mean relative humidity of each month; complete saturation being* 1·000, *or unity.*

	9 A.M.				3 P.M.			
Name of the month.	Mean elasticity of vapour.	Mean weight, in grains, of vapour in a cubic foot of air.	Mean additional weight of vapour required for complete saturation.	Mean relative humidity.	Mean elasticity of vapour.	Mean weight, in grains, of vapour in a cubic foot of air.	Mean additional weight of vapour required for complete saturation.	Mean relative humidity.
	in.	gr.	gr.		in.	gr.	gr.	
Jan. ...	0·229	2·70	0·17	0·94	0·242	2·84	0·38	0·89
Feb. ...	·218	2·58	0·25	0·91	·231	2·72	0·62	0·82
March	·235	2·77	0·40	0·87	·243	2·85	1·05	0·74
April	·281	3·26	0·68	0·84	·290	3·37	1·41	0·71
May ...	·350	4·02	1·10	0·79	·353	4·06	2·04	0·67
June...	·414	4·71	1·45	0·78	·421	4·78	2·42	0·65
July ...	·447	5·07	1·50	0·77	·465	5·26	2·27	0·67
August	·441	5·00	1·18	0·81	·447	5·07	2·27	0·69
Sept.	·409	4·66	0·73	0·88	·419	4·77	1·93	0·71
Oct. ...	·344	3·96	0·35	0·92	·349	4·01	1·08	0·79
Nov....	·282	3·27	0·22	0·94	·295	3·42	0·55	0·86
Dec....	·235	2·78	0·17	0·94	·246	2·89	0·37	0·88

The mean elasticity of aqueous vapour in the atmosphere is in the summer nearly *double* what it is in the winter.

The *quantity* of vapour the air can contain depends upon its *temperature.*

By consulting the above Table we find the air more nearly saturated in January with 2·84 grs. of vapour in a cubic foot, than in July with 5·26 grs.

The mean relative humidity of the air is greater at 9 A.M. than at 3 P.M.; the mean quantity of vapour in this interval actually *increases*, but as the increase is *not* in proportion to the increase of *temperature* in the same interval, the air is relatively drier.

November, December and January, are the months in which the least variations between the temperature of the air and the temperature of the dew-point occur; and in these months the air is the most frequently saturated with vapour; as spring advances, the air becomes *relatively to temperature* drier. In the month of April 1847, the *mean* difference between the temperature of the air, and the temperature of the dew-point at 3 P.M, was 14°; the greatest difference did not exceed 20°; the temperature of the air was always below 60°; the winds chiefly from the north and east. On the 23rd of June 1845, the difference between the temperature of the air and dew-point was 22°; the relative humidity of the air was 0·49; the wind north. In June 1846, the *mean* difference between the temperature of the air and the temperature of the dew-point at 3 P.M., was 18°; the greatest difference was 23°, the relative humidity of the air being 0·47. On the 4th of July 1846, the temperature of the air at 3 P.M. was 83°, the temperature of the dew-point 32° *below* it: the relative humidity of the air was 0·37, the greatest dryness observed; the pressure was high, the wind south-west, and the sky cloudless. On the 5th the temperature rose to 90°, and a thunder-storm followed. On the 16th August 1842, the temperature of the air was 87°, and the temperature of dew-point 30° *below it.*

The *mean* temperature of the dew-point at 9 A.M. and 3 P.M. is nearly alike all the year round; if the temperature of the *dew-point rise* as the day advances, it is an indication of rain; if it remain *stationary*, or *fall*, fine weather may be expected. Much rain may follow an *extreme* difference between the temperature of the air and the temperature of the dew-point; and the air may be saturated with vapour for many hours during the winter season, and no rain fall.

The condensation of vapour occasioned by the intermixture of warm and cold currents of the atmosphere, produces those numerous and diversely formed clouds from which the earth receives its rain, snow, hail, &c.; the clouds have each an individual character, and have been distinguished by Luke Howard by the following nomenclature:—Cirrus, Cirro-stratus, Cirro-cumulus, Cumulus, Cumulo-stratus, Nimbus, Scud, and Stratus; they follow relatively to each other the order in which they have been named; for although in the summer they attain a greater elevation than in the winter, yet the Cirrus is never seen below the Cumulus, or the Cumulus below the Stratus. The great height at which the Cirrus is formed, the low temperature and attenuation of the atmosphere at that height, and the consequently small quantity of vapour it can contain, explain the delicate and beautiful structure of this cloud; it is never wafted from place to place, like other denominations of cloud; it is generated where it is seen, and its rapid ramifications and feathery forms are shot forth in a manner so analogous to the crystallization of vapour upon glass, that it seems beyond a doubt that its formation arises from the crystallization of vapour, at a temperature considerably below the freezing-point; as the Cirrus increases, and becomes denser, it descends, and meeting in its descent with more vapour, it spreads rapidly, and a uniform neutral-coloured cloud overspreads the heavens; this cloud is the Cirro-stratus; the vapour is now at its greatest elasticity, and a reduction of temperature causes rain or snow to fall. The Cirro-cumulus is dappled on the sky in small ragged flocks like wool;

this is the fine-weather cloud. The Cumulus, or day-cloud, is produced by a quick evaporation, caused by the action of the sun's first rays upon the surface of the earth; the temperature of the lower atmosphere being too high for the vapour as it is raised to become visible, it ascends, until it meets with a degree of cold to condense it, when it assumes the irregular arched form of the Cumulus; as the day advances, and the atmosphere becomes heated, the cloud rises and increases in density, until two or three hours after noon, when the evaporation from below being less, and the ascending warmth having increased the capacity of the air for containing moisture, the vapour itself gradually expands, the rocky summits of the Cumulus by degrees change their arched forms, small portions are detached, and the cloud at last dissolves. Rain never falls from the Cumulus when seen alone, but there are states of the atmosphere, more especially in the spring and summer months, when the increasing altitude of the sun combining to promote a quick evaporation, and the north-east and east winds are struggling for the ascendency over those from the warmer westerly quarters, that the Cumulus appears to be checked in its ascent, and to undergo a sudden and rapid condensation; for its density increases, its summits grow confused, and its dimensions extending, overspread the sky; in this form it is a compound of the Cumulus, tufted with Cirrus, and fringed below with the Stratus, and therefore called the Cumulo-stratus; this cloud always chills the air; thunder, squalls of wind, hail, snow, and impetuous showers are its characteristics. The Nimbus is a cloud from which rain is actually falling. Scud is large shapeless masses of vapour driven by the wind; and the Stratus is formed from the lower atmosphere being colder than the surface of the earth; it is seen only in calm weather. The formation of all these modifications may be observed upon the approach of a heavy thunder-storm. The deep blue sky grows turbid from an anomalous haze extending round the horizon, and even reaching over-head; the Cirrus cloud lies lightly on the southern or western portions of the heavens, small patches of Cirro-cumulus suddenly appear, but so electrified that we seek instinctively the Cumulus, whose bold and convex tops, backed by the Cirro-stratus, we trace beneath the haze; the distant thunder mutters, the lightning darts from cloud to cloud, or from their flattened bases strikes at intervals the earth; dense Cumulo-strati overspread the sky, and huge masses of scud-like cloud hurrying from every quarter of the heavens envelope all in darkness; then come the rush of wind, the blaze of lightning, and the crash of thunder, the mighty torrent and the rattling hail: the rain abruptly ceases, a momentary calm ensues; with energy renewed, the clouds again discharge, with scarce an interval between them, lightnings more fierce, and thunder, which, shaking earth itself, appals Creation;—the storm has passed the zenith, slowly it travels onwards, bearing in its track the flying scud, which feebly feeds its nearly exhausted power; the cataract subsides into a gentle rain, the sun gleams through the parting clouds, and clear blue sky appears;—far distant in the horizon the rocky pile is seen in bold relief upon the sky, its summits gilded by the setting sun; gently it dissolves, and save a few faint bands of streaky cloud, the heavens are left serene. In an elevated situation, commanding an extensive and uninterrupted view, the different states of the atmosphere may be observed from the various modifications of cloud above the horizon; overhead may be seen the Cumulus; more distant, casting its deep shade over the landscape, the Cumulo-stratus; on the one side the Nimbus, distributing its genial shower, and on the other a haze or mistiness, denoting hot, calm weather. The colour of the sky when free from cloud varies in intensity; in fine serene summer weather it is of a deep blue, but towards the end of autumn, and during the winter months, when the atmosphere is loaded with vapour, it is usually of a very pale colour. At the latter end of spring and in the early part of summer, a peculiar blue haze sometimes prevails in hot, dry, easterly winds; it was very remarkable in the vicinity of London in the months of May and June in the year 1846. The modification and quantity of cloud are the indices of the climate of a country; where the Cirro-stratus and Scud prevail, they not only maintain a nearly uniform temperature during the twenty-four hours, but they precipitate a small and continuous rain, usually accompanied by a warm surging wind; where the Cumuli modifications prevail, there are ardent and glowing skies, whose meridian heat is tempered by the fleecy Cirro-cumulus and Cumulus, which latter, passing into the Cumulo-stratus, refreshes nature with copious rains, and leaves the atmosphere clear and calm, to carry off the superabundant heat of day; the extremes of temperature during the twenty-four hours amounting probably to 25° or 30°.

Clouds have a great influence on terrestrial radiation, a phænomenon of temperature worthy of particular attention: on a clear, calm night, a *greater* degree of cold occurs on the *surface* of the earth, than in the atmosphere a few feet above it; the fact was first noticed by Mr. Sixe, and subsequently applied by Dr. Wells in the explanation of his theory of the formation of dew. All bodies, in their tendency to an equality of temperature, give out rays of heat, and receive others in return: in bodies of unequal temperatures the warmer body parts with more rays than it receives and becomes colder, and the colder body parts with less than it receives and becomes warmer; this continues until the interchange of rays becoming equal, both bodies have the same temperature. Without speculating upon the absolute temperature of the space in which our planet revolves, we know that the loftier and rarer portions of the atmosphere are to our bounded conceptions, infinitely cold compared with the temperature of the denser portions in immediate contact with the earth; and that therefore all circumstances being favourable, the lower atmosphere will radiate more heat upwards than it will receive in return. When the sun sinks below the horizon and no longer keeps up the supply of heat to the earth, the decrease of heat by radiation is very apparent, the temperature declines and falls to a mininum about half an hour before sunrise; this we learn from the indication of a thermometer, placed a few feet above the ground; but if on a clear calm night a thermometer be placed upon the surface of the earth, it will, according to the texture of the substance upon which it may repose, fall from 2° to 15° lower than the one placed above it. The temperature from radiation is the lowest upon those bodies which are the worst conductors of heat, and as radiation takes place only from the *surfaces* of bodies, all rough and filamentous bodies by increasing those surfaces are the best radiators: the radiating power of the following substances increases in the order in which they are named,—gravel, mould, ploughed ground, downy plants, meadow-grass. The winter season affords examples that bodies which radiate freely are bad conductors of heat; if a thermometer be laid on a ploughed field, and another on the grass of an open meadow, the former will show a less degree of cold than the latter, from which it might be inferred that the earth beneath the grass was more intensely frozen than the ploughed ground; anomalous as it may seem, the soil beneath the grass will be soft and free from frost, and the ploughed ground will be frozen so hard that no impression can be made on it; grass is a bad conductor, and the heat from the earth does not traverse it quickly enough to supply the loss of that which escapes from its several surfaces; the ploughed ground, being a better conductor, replaces from below the heat which has been carried off from above, and maintains the temperature. Snow is a bad conductor, and although during intense frosts the ground may be covered with it, and a thermometer placed thereon stand at zero, as on the 12th of February 1845, yet its power of conducting heat from the earth beneath it, is so slow, that vegetation is not exposed to a temperature below 32°. "He giveth snow like wool, He scattereth the hoar-frost like ashes."

The following observations are an instance of the intense cold produced from radiation, and also of the influence of locality; they were made in an open field at Lee, in Kent, on the evening of the 19th of October 1843:—

Time of observation.	Thermometers on				Remarks.
	Grass.	Wool.	Wadding.	In open air.	
m	°	°	°	°	
5 15	24	24	23	35	No frost yet visible.
6 0	19	17	18	30	Dew on the grass begins to freeze.
6 30	18	12	15	28	Grass everywhere frozen.
7 0	16·5	13·5	14	28	Grass everywhere frozen; mist rising.
7 30	15	12	15	27·5	Hedges covered with hoar-frost.
8 0	13·5	10	12	27	Fog in upper atmosphere; every object now covered with rime.

The temperatures on the grass were obtained from very thick meadow-grass.

The thermometer in the open air was suspended from the twig of a hedge, about 8 *feet above the road-side.*

Perfectly calm during the time of observation; the wind during the day had been N.

At Greenwich there was no appearance of frost, objects were covered with moisture, and a thermometer 5 *feet above the ground indicated at* 10 P.M. *a temperature of* 32°*; the minimum for the night was* 27°.

In the above experiment we have an example of water being cooled down several degrees below the freezing-point before it became solid, in the dew on the grass, which did not freeze until the temperature of the grass had fallen to 19°, or 13° below the freezing-point.

The temperature from radiation begins to recede shortly before sunset; its fall at first is rapid, and should the night continue calm and cloudless, a great depression ensues, although not in proportion to its first abrupt descent. The effect of radiation is greater in a free and open space than in a confined locality; a light breeze, a thin cloud in the zenith retards it, and if the clouds thicken and cover the sky, the temperature rises; indeed so susceptible is the radiating power, that a sudden cessation of it is an unerring proof that clouds are forming. In rainy, covered weather, if the clouds roll off the zenith, the temperature falls suddenly, and upon the clouds again overspreading the sky it immediately rises; during these temporary breaks, cold of great intensity sometimes occurs, of which we should remain in ignorance unless a thermometer were placed upon the surface of the ground.

The following table shows the *mean* of the *lowest* readings of a thermometer placed on garden-mould, and the *mean* of the *lowest* readings of a thermometer suspended 5 feet above it, for every month of the year, deduced from thirteen years' observations made at Greenwich from 1830 to 1842:—

Month of the year.	Mean of the lowest readings of a Thermometer on the ground.	Mean of the lowest readings of a Thermometer placed 5 feet above it.	Difference.
January	14°·2	16°·0	1°·8
February ...	19·5	21·7	2·2
March.........	22·8	25·6	2·8
April	24·0	26·6	2·6
May	31·4	33·8	2·4
June	38·7	40·9	2·2
July	42·2	44·0	1·8
August	41·4	42·5	1·1
September ...	35·5	37·3	1·8
October	27·6	30·9	3·3
November ...	24·2	26·0	1·8
December ...	21·5	23·2	1·7
Means.........	28·58	30·70	2·12

In the foregoing table, June, July, August and September, are the months of the year in which the *mean* of the *lowest* temperatures from radiation on garden-mould does not descend to the freezing-point: in May the cold from radiation has occasionally a very destructive influence on early vegetation, as in 1831, 1838 and 1839, when the early crops of scarlet beans, potatoes, &c. were destroyed: in June 1837 the thermometer on the ground fell to 35°; in 1843, on the grass in Greenwich Park, it fell on the nights of the 6th, 21st and 23rd to 33°·5; in July 1843, on the nights of the 24th and 25th, it receded to 37° and 36°; in August a temperature from radiation below 40° is not so rare. If these be the results of observation in the neighbourhood of a large metropolis, we can scarcely err in assuming, that in the central and exposed parts of the kingdom, the *mean* of the *lowest* temperatures from radiation in June would be below 32°.

To obtain a certain degree of cold which takes place at night from radiation, a thermometer is placed in a highly polished parabolic reflector, the bulb being placed in its focus; by this contrivance it is insulated from every object but the reflector and space above; as the heat from the bulb of the thermometer escapes, its rays are received by the reflector, whose polished surface *reflects* them in right lines upwards into space; the bulb constantly giving out more rays of heat than it can receive in exchange, acquires a very low temperature compared with that of other bodies which have been exposed to a reciprocal radiation.

The following table shows the *mean* of the *lowest* readings of a thermometer placed in a parabolic reflector, and the *mean* of the *lowest* readings of a thermometer suspended 5 feet above it, for every month of the year, deduced from eight years' observations made at Greenwich from 1842 to 1849 :—

Date of the year.	Mean of the lowest readings of a Thermometer placed in a parabolic reflector.	Mean of the lowest readings of a Thermometer 5 feet above the ground.	Difference.
January	16°·1	21°·9	5°·8
February......	14·4	20·3	5·6
March.........	17·0	23·2	6·2
April	22·6	28·5	5·9
May............	28·8	35·2	6·4
June	37·1	43·1	6·0
July............	38·5	45·2	6·7
August	37·6	44·8	7·2
September ...	32·4	38·7	6·3
October	25·4	31·2	5·8
November ...	19·3	26·0	6·7
December ...	17·4	23·4	6·0
Means.........	25·5	31·78	6·23

From the preceding table, June, July, August and September, are the only months of the year in which the *mean* of the *lowest* temperature in the reflector does not descend below the freezing-point; on the 14th of June 1849, the temperature in the reflector descended to 32°.

Grass is the vegetable production upon which at present the lowest temperature from radiation has been registered; favoured by locality and soil, it would probably coincide in general with that registered in the reflector. At Greenwich, on the 6th of July 1842, after a shower which fell at 7 P.M. from a passing nimbus, accompanied by much wind, it became nearly calm, and the atmosphere almost free from cloud; a thermometer in the reflector stood at 52°, and one placed about 4 feet above it at 58°; a thermometer placed upon the grass receded in a quarter of an hour to 50°·5, in which time the one in the reflector had fallen to 50°·9; observations were continued, of which the following are the result:—

Time.	Thermometer		
July 6.	in the reflector.	on grass.	
h m	°	°	h m °
8 30P.M.	48·9	45·1	*Therm. suspended in the air at* 9 30 55.
8 45	47·0	43·2	*Minima for the night.*
9 0	46·1	41·9	39° *on grass.*
9 15	45·3	40·0*	37°·5 *in reflector.*
9 30	45·1	39·2	46°·0 *in the air.*

* Bulb covered with moisture.

During fine calm weather in the day-time, when the sky is overspread with thin white clouds, heat is radiated from them *downwards* to the earth, which raises the temperature at its surface 2° or 3° above that of the air; this radiation is peculiar to the spring months, and in conjunction with a large amount of warmth, reflected from large Cumuli, appears to assist the development and progress of early vegetation.

Dr. Wells, in his theory of the formation of dew, has shown that dew is produced from the effects of radiation, which cooling the atmosphere in contact with the radiating surface, condenses the vapour contained in it; the vapour at first is deposited in small vesicles, which as the cold increases, and with it the deposition, collects into drops called dew. Good radiators collect much dew, bad radiators very little: vegetation, whose leaves are spicular or hairy, as grass, &c., on a night favourable to radiation is covered with dew; while plants, whose leaves are smooth, as the laurel, ivy, &c., are dry;

when the temperature sinks below the freezing-point, the dew appears as hoar-frost and rime.

The temperature of the atmosphere decreases as we ascend from the surface of the earth; the mean decrease is about 1° of Fahr. for every 350 feet:[*] "the temperature at any given height depends upon the temperature of the atmosphere below: in the new continent between the tropics, the lofty Cordelierras, at the height of 10,000 feet, are the centre of civilization and industry, the mean temperature at that altitude rising to 58°, while in the temperate zone a fixed population is rare beyond the height of 6500 feet, and the line of congelation sinks so low that the cultivation of grain ceases at the height at which it commences in the Cordelierras: in the Cordelierras between the tropics, at the height of 6500 feet, we find the mean temperature of Sicily and Calabria; and in the temperate zone, in lat. 46°, at the same elevation, we have the mean temperature of Lapland."

On the Climate of the East of England.

Places which have the same annual quantity of heat, or the same mean temperature, are said to be in the same isothermal line[†]. New York in America, lat. 41°; Sevastopol, north of the Black Sea, lat. 44°; the west coast of America, north of the river Columbia, lat. 45°; and the meridian of London between 52° and 53° of latitude,—have all very nearly the same mean temperature, and are therefore in the same isothermal line; but it is not to be inferred, because they have the same *annual* quantity of heat, that they have identical climates;

---

[*] Des Lignes Isothermes, Humboldt.

[†] ἴσος *equal*, and θερμὸς *hot*.

for the heat being variously distributed throughout the seasons, diverging in some places into extremes in the winter and summer, and in others being more equally divided throughout the year, differences in the meteorological conditions of the several countries are established, which necessarily produce differences in climate and vegetation. England is subject to a variable climate, not only from its insular form, but it is liable to further violent changes, from the never-ceasing antagonism of a warm maritime climate on its western side, with a cold continental climate on its eastern. The great Atlantic which washes the west and south-west shores of England, produce in those counties exposed to its influence, a warm, moist atmosphere; for the westerly winds which constantly prevail there, carry thither the warm air from over the sea, and the vapour with which it is laden is condensed as it reaches the colder land into a misty scud, which drenches every object with moisture although no drops of rain may fall; as the scud is driven inland, it meets with drier strata of the atmosphere, and rising it assumes other modifications of cloud, and at last falls in heavy Nimbi; these Nimbi succeed each other with remarkable rapidity: clear blue sky is no harbinger of settled weather, unless the wind veer to the N. or E.; immediately it deviates towards the W., the sky becomes milky and showers follow. The continual condensation of so much vapour contributes to the high winter temperature of the west of England; low temperatures occur occasionally, as on the nights of the 14th, 17th, and 20th of March 1845, when a thermometer at Shillingford Cross, near Exeter, descended to 13°, 15°, and 20°, and the myrtles even in the south of Cornwall were partially injured; but these are rare cases, as the cottages covered with myrtles, the gigantic fuchsias, the hydrangea, and the luxurious growth of the tamarisk, arbutus, and tender evergreens, testify. The quantity of vapour in the atmosphere weakens very much the power of the sun's rays during the summer period, so that the temperature never rises to extremes; the air is mild, and so exquisitely downy to the sensations, that you ever court the sweet breath of heaven. Kent may be the garden of England, but Devonshire and the neighbouring counties are certainly England's Eden.

The great power of the westerly winds influences the character of the winters in the eastern parts of the country; when they prevail, the season is mild and damp, and the winds are boisterous; the temperature never rises above 44°, but the wind from the Atlantic increases to a gale; and it is not unusual at the end of January, or in the middle of February, for the temperature to range as high as 48° and 50°, and for vegetation to be ready to burst the bud: as the month of March advances, the influence of the proximity to the continent begins to be felt, in the predominance of north-east and east winds, which coming from the regions of Siberia and the frozen Baltic, check the rising temperature; the excessive dryness of these winds accelerates evaporation so much, that the heat derived from the increasing altitude of the sun is in great part carried off in the formation of the vapour required by the great capacity of the air for moisture, so that vegetation has to contend at one and the same time by day with a hot sunshine, and a cold from evaporation, and by night to a cold from radiation; the easterly winds attain their maximum in May, therefore if an average spring succeeds a mild winter, the frosts of March and April may be expected to destroy the tender shoots which were hurried forward; and if May and June be dry, nature has no time to recruit herself, to withstand either the heats of July, or its too probable constant and heavy rains.

A tolerable notion of the climate of the eastern parts of England may be formed from the following extract of results from a journal kept at Greenwich, Kent, and extending over a period of thirty-five years. In speaking of the seasons, winter will comprehend the *previous* December, January, February; spring, March, April, May; summer, June, July, August; and autumn, September, October, November. The mean temperature of the winter months is 38°·2; the ratio of the winds from S.S.W. to W., and from N.N.E. to E., is as 2 to 1; and the average number of frosty nights 37·5; therefore, on a mean, a period of long-continued frost cannot be expected. The winters within the last thirty-five years, in which the greatest number of frosty nights have occurred, were those of 1814 and 1830; in the former they amounted to 62, and in the latter to 70; in 1814 the temperature in the month of January fell every night below 32°, and in February on nineteen nights; the temperature did not deviate into extremes, the lowest being 10°; the winds blew from N. to E., the sky was cloudy, and a great depth of snow fell. In 1830 there were 23 frosty nights in December, 27 in January, and 20 in February; the temperature of the first seven nights of February fell below 20°; the wind, which since the commencement of December had scarcely moved from the N. and E., changed on the 7th of February to S.S.W., and on the morning of the 8th the temperature rose to 46°; during this period of frost the sky was always clouded. The years 1820, 1838 and 1841, were distinguished by *extremes* of cold, which were of short duration, the winds introducing them were from N. to E. On the 15th of January 1820, the minimum temperature was 3°, on which day the wind changed to the W., and the cold mitigated. In 1838 the month of December was singularly mild, as was also the early part of January; on the 7th an easterly wind set in, the cold gradually increased until the night of the 14th, when the temperature fell to 6°·5; it fluctuated between 15° and 30° until the 19th, when it sunk to −4°; the wind then changed to the S.S.E. and S., and on the 21st the minimum temperature was 36°: the cold of the 19th was preceded by a gale from the E., with a rising barometer and cloudy sky; the mean temperature of February was below the average. In the winter of 1841 the number of frosty nights in December was 23, the minimum temperature on the 18th 16°·6; the prevailing winds were from N. to E., the sky generally cloudy, with a casual clear break; in January the lowest temperature was 5°·4 at 4 A.M. of the 9th; the current of air on the 5th, 6th and 7th, had been E. and N.E.; on the 8th and 9th the wind changed to the W., and at noon on the 10th the temperature was 36°; on the 3rd of February the temperature fell to 13°, after which the cold moderated, and a south wind set in on the 10th. In the year 1816 a transient period of cold occurred on the 8th, 9th and 10th of February, when the temperatures were severally 16°, 8°, and 6°; it had been preceded by a N.E. gale and a fall of snow; the wind changed on the 10th to the S., and the temperature at noon rose to 29°: the character of this winter was mild. The mildest winters within the last thirty-five years, were those of 1822, 1834 and 1846, in which the number of frosty nights were severally 12, 17, and 19; in the winter of 1822 there was one frosty night in December, when the temperature receded to 31°; the wind E., the only day in the month on which it blew from that quarter: the great features of the month were gales from the S.S.W., with rain to the amount of 4·72 in., in January the minimum temperature was 27°, the westerly winds prevailed, those from the easterly points blowing but three times during the month; in February the minimum temperature was 29°, the winds from W. to S. throughout the month. The winter of 1834 was remarkable for its high temperature: the thermometer in December ranged as high as 55°; the winds were from the S. to W. and rain fell to the amount of 4·5 inches; the mean temperature of January was 8° higher than the average; in February the highest temperature was 55°·5, the minimum 23°·5; the number of frosty nights was 11; the winds were chiefly from the W.: it blew but once from the E. during the month. In the winter of 1846 the number of frosty nights in December was 8, the maximum temperature rose to 55°·5, and the minimum fell to 27°·5; the winds were all from the westerly quarters; in January the temperature rose on fourteen days above 50°; the minimum cold was 28°·5, and, as in the preceding month, the winds did not once veer to the E.; February was proportionably mild, the temperature on the last day of the month rising to 60°: these winters were succeeded by fine warm summers. During the three winters in which the number of frosty nights exceeded the average, the winds ranged from N. to E., the skies were clouded, and much snow fell, and it is worthy of remark that the *extreme* of cold was immediately succeeded by a change of wind to the S. or W., and that a thaw ensued. During the three winters in which the number of frosty nights was less than the average, the winds were always from the W. to S.; violent gales were frequent, and rain in large quantities fell. The mean temperature of the winter season being 38°·2 when the *westerly* winds prevail, the daily mean may rise several degrees *above* the mean of the month, and a period of mild weather may ensue; and when the *easterly* winds preponderate, the daily mean may fall several degrees *below* the mean of the month, and a period of cold follow; a rise of 2° or 3° in the daily mean above the mean of the season, gives all the appearances of a mild climate; the grass is green, the rivulets run freely, and the ponds and still waters are full and limpid; a fall of 8° or 10° below the mean of the season binds up the ground with frost, snow lies deep in drifts, and even running waters are blocked with ice: it is these absolute changes from *frost* to *thaw* and from *thaw* to *frost*, that characterize the English climate, and which are so inimical to the health of man and to vegetation. The effects of a departure from the mean temperature of the month are well contrasted in the months of January 1838, and 1834: the mean temperature of January is 36°·46; in the year 1838 it was depressed to 28°·28, and in 1834 it was elevated to 44°·18; in the former year the laurels, lauristinas, ivies, bays and cypresses were scorched by the cold, greenhouse and garden plants destroyed, and the weeds by the road-side withered to their roots; birds and animals without shelter were frozen to death, and man could scarcely exclude the cold from his dwelling; moving icebergs, rolling and dashing against each other, covered the middle of the channel of the river Thames, and fields of ice blocked up its banks: in the latter year, on the 26th of January, the crocuses, snowdrops, violets, and polyanthuses, together with the almond-trees, were in blossom; on the 28th of February the wall-fruit trees were in full bloom, and the gooseberry bush in leaf, and by the 10th of March all the fruit-trees, with the exception of the apple-tree, were in full bloom.

The mean temperature of the spring months, March, April and May, is 47°·55; the ratio of the winds from S.S.W. to W., and from N.N.E. to E., is equal, and the average number of frosty nights is 14·5; the mean heat of the nights has increased 6°, one-half of which increase is due to the month of May; the mean heat of the days has increased 12°·5. At this season the rocky Cumulus is seen in all its grandeur, but it now passes rapidly into the Cumulo-stratus cloud, from which, in March and April, hail, sleet and snow, as well as rain, are discharged: thunder is rare in March, but in April, after sudden heats with an easterly wind, an occasional clap is heard as the dense clouds follow in quick succession, and pour down heavy showers of rain mixed with hail and sleet; as evening approaches these clouds evaporate, and the sky being left clear and serene, low temperatures from radiation occur. The probability of hail is less in May than in April by one-half, but the probability of thunder is more than doubled. Thunder in the spring generally introduces cold and wind; on the 30th of April, in the year 1827, the temperature rose to 77°; lightning was seen at night, and on the morning of the 1st of May thunder was heard to the south; the temperature gradually declined, until on the morning of the 8th the ground was covered with hoar-frost. The average number of frosty nights in March is 9; the greatest number, 21, occurred in 1833, and the least number, 1, in 1822; the average number of days upon which rain falls is 9, and upon which snow or sleet falls, 3; the greatest number of days, 15, upon which rain fell was in 1815, and the least number, 1, in 1825; and snow fell on 10 days in 1845. The month of March 1845 was remarkable for its severity; the maximum temperature on the 12th was 22°, and on the morning of the 13th, at Hyde Vale, shortly before sunrise, it receded to 12°·5, and upon the snow to 6°: the mean of the maximum temperature (by day) for this period is 47°, therefore on the 12th the temperature was 25° lower than the average; during the day there had been much sunshine, a strong N.E. wind had blown, which at night became nearly calm: the sky at night was cloudless. On the 19th the temperature at noon was 27°, the wind blowing a gale from the E., with snow; the mean of the month was below the average mean of January. The month of March in the year 1822 was unusually mild, the maximum temperature rose to 67°·5; the winds varied from S. to N.N.W., but the prevailing winds were from the S.W. and W. The average number of frosty nights in April is 4·2; the greatest number, 13, occurred in 1834; and in 1815 and 1819 there were no frosts; the average number of days upon which rain falls is 10; the greatest number of days upon which it fell was 21, in 1833, and the least number, 4, in 1827, 1834, 1840, and 1844; the average number of days upon which snow or sleet falls is 2; the greatest number of days upon which it fell was 7, in 1837. The month of April in the year

1837 was very inclement; the number of frosty nights was 13; the minimum temperature, which took place on the 12th, was 23°·2; from the commencement of the month until the 18th, the winds blew from N. to E., and there were occasional showers of hail, sleet and snow*. On the 7th the aurora borealis was seen. On the 15th not a standard fruit-tree was in blossom; the trees were untinged with green, the laurels were bare of leaves, and the general aspect of the country was the same as it had appeared at the end of February. In the year 1844, the month of April was mild; there was one frosty night during the month; the days were generally warm, the maximum temperature rising to 75°; the wind blew but three times from the E. until the end of the month, when it set in from that quarter, and blew steadily from N. and E. throughout the month of May: the sky was brilliantly clear, and the atmosphere so dry that the temperature of the dew-point ranged constantly from 15° to 20° below the temperature of the air. On the 13th the hawthorns were green; on the 16th, the pear, cherry and plum-trees were in bloom, and the horse-chestnut in leaf; and on the 30th the apple-trees were in full blossom. The average number of frosty nights in May is 1 in 2 years; the greatest number, 4, occurred in 1831 and in 1839: snow or sleet falls on an average once in four years; it fell three times in 1839; the average number of days upon which rain falls is 9·6, the greatest number of days on which it fell was 23 in 1843, and the least number, 2, in 1848; the *lowest* temperature observed in May was in 1831, when on the 7th of the month it descended to 27°; the

---

* Kent was visited by a great fall of snow so late as the 19th of April, 1849.

temperature on the *surface* of the ground was 24°. In the year 1837 the month of May was cold; the minimum temperature on the 10th receded to 31°, and the thermometer placed upon the *surface* of the earth fell on six nights below the freezing-point; the temperature by day ranged generally below 60°; on the 10th snow fell, and on the 19th sleet was mixed with the rain, which fell on that day; an aurora borealis was seen on the 6th; on the 15th the generality of fruit-trees, the apple-tree excepted, in blossom. In 1833 May was dry and warm; on the 4th of the month the temperature rose to 78°, and on the 15th and 17th to 81°; the wind in each case S.E.; the rain which fell during the month amounted to 0·61 in.

The mean temperature of the summer months, June, July and August, is 61°·4; the ratio of the winds from N. to S. as 2 to 1, and of those from N.N.E. to E., to those from S.S.W. to W., as 1 to 2·2; the power of the winds from the westerly points is double that of the winds from the other quarters: the average power of the winds, taken collectively in June, July and August, is 1·7, 1·6, and 1·5*: in June the air is seldom tranquil, and towards the middle of the month very violent gales are experienced from the S.S.W. to W. In the year 1833, on the evening of the 10th, the sky was clear and serene; at 6 A.M. of the 11th, thunder-clouds were visible to the N., which gradually gave way to a lowering scuddy sky, driven up by a S.W. gale, which rose about 9 A.M; a brisk shower fell at 3 P.M., after which the wind rose to a perfect hurricane, uprooting trees and shrubs, &c.; the temperature, which at 7 A.M. had

---

* 0, denotes a calm; 1, a breeze; 2, a fresh breeze; 3, high wind; 4, tempestuous; 5, a great storm; 6, a hurricane.

been 70°, fell in the afternoon to 56°. In July the most stormy winds are from the S.S.W. and W.S.W.; in the year 1837, on the 29th of the month, it blew a steady gale from the S.W. for twelve hours, blowing down trees and scattering the fruit; in the year 1839 the thunder-storms were very extensive, and were succeeded by heavy gales from the S.S.W. to W., which did considerable damage by laying the corn. In August the S.W. wind blows frequently, but its power on the average is moderated; the gales, which occasionally blow with great violence, proceed from the N.N.W., S.S.W., and W.S.W. On the 4th of August, 1825, a violent tempest blew from the S.S.E. to W. which unroofed houses and tore off huge limbs of trees; on the 9th in the year 1828 the wind backed to the S. and blew a gale which destroyed trees, damaged buildings, and stripped orchards of their fruit. One of the heaviest gales on record for the month of August occurred on the 30th and 31st in the year 1833; the wind backed to the S., and as it gradually veered round by the W. to N.N.W. it blew violently from all the intermediate points; many trees were blown down in Greenwich Park, buildings were damaged, and the hop-gardens and orchards in Kent sadly injured; the accounts from the coast were appalling, fifty-nine vessels were reported at Lloyd's; in this fearful gale the Amphitrite convict-ship was lost, and all on board perished. During the prevalence of high winds from the westerly points in summer, the sky is so constantly clouded that the range of temperature in the twenty-four hours does not exceed 10°, while in clear calm weather the range is sometimes as much as 30°. The unsteadiness of the heat in the summer months is shown in July 1836; on the first five days the temperature rose above 80°; on the morning of the 5th it was 81°; it rose to a maximum of 86°, and at 6 P.M. it stood at 82°, the wind at E.: thunder succeeded on the 6th, and as the month advanced heavy squalls and boisterous winds from the S.W. were frequent; the temperature on the 20th at 1 P.M. was 49°, the maximum 56°. A fine aurora borealis was seen at midnight on the 2nd of the month. The summers of 1818, 1825 and 1826 were distinguished for the excessive heats of July; these great heats may be the effects of the hot winds blowing from the great desert of Africa: it usually happens when they occur that the heat in the south of Europe is increased, and the winds are uniformly S. and S.E. The greatest heat on record was on the 13th of July 1808, when the temperature in the shade rose to 95°: the mean heat of that day was nearly 80°*. On the 25th of July, 1818, the temperature at the Royal Observatory rose to 93°; in July 1825 it rose during the month three times above 90°; and in July 1846 the temperature at noon was 90°: the heat on this day was transient; a thunder-storm came up suddenly and chilled the air. On the 18th of August 1842, the temperature rose to 90°; the temperature of the dew-point at 3 P.M. was 24° below the temperature of the air; soon after 5 P.M. a haze appeared in the S.W., and the Cirrus cloud became visible and gradually covered the sky; before sunset a strong breeze, dry and harsh to the sensation, rose from the E. and E.S.E., and large broken and apparently highly electrified Cumuli passed over from the S.; at 8 P.M. the temperature was 79°, at 10 P.M. 76°, and at midnight it again rose to 77° and 78°; at this time the temperature of the dew-point was 68° and 70°; at 1 A.M.

---

* Being equal to the heat of Egypt, or Upper Ethiopia.

the sky became nearly cloudless, and the temperature suddenly declined 10°; the E. wind, which seemed like a sirocco, died away about 3 A.M. and was succeeded by a fresh breeze from the S.W.; no lightning was seen throughout the night: this was no doubt the highest nocturnal temperature ever registered in this climate. High temperatures accompanied by sultriness at an early hour of the morning appear to be the effect of electricity; they are seldom followed by hot days, light rain usually falls, and the temperature declines. The average number of days in the year in which the temperature may rise to or above 80° is 6·5. The average number of days on which rain falls in the summer months is 9·5 in June, 11 in July, and 10 in August; the greatest quantity which has fallen in each month is 4·3 in. in June in 1838, 6·35 in. in July 1828, and 4·6 in. in August 1837. Thunder is more frequent in summer than at any other season; in June it proceeds chiefly from the Cumulo-stratus cloud, and as this cloud is invariably simultaneous with a cold and dry atmosphere, so thunder is usually the precursor of cold and wind in the summer months: the probability that the Cumulo-stratus will produce thunder instead of hail appears to increase as spring advances in the following rough approximations; in March as 0·01, in April as 0·02, in May as 2·0, and in June as 5·0; in July and August the thunder-storms are of great magnitude, and extend over a large area of country; they occur more particularly about the 18th of July, and towards the latter end of August: it is peculiar to Greenwich that it is seldom visited by the brunt of these storms; as the clouds approach the zenith they split and pass to the S.W. and N. In July and August hail falls only during violent thunder-storms; it differs from the hail of spring in its perfect transparency and irregular and jagged form. On the 1st of August 1846, the wind being at E. and the temperature at 85°, cumuli, from which thunder was heard, came up from the S. and passed the zenith at a quarter to 4 P.M.; very large hail and transparent pieces of ice were discharged from the clouds, which broke several windows in the neighbourhood; the progression of the storm was to the E. and N.E., where the destruction of glass from the hail was calamitous; at Greenwich 1·56 in. of rain fell, but at other places near the metropolis it amounted to 3·0 in.

Summers with a mean temperature of about 62° are the most congenial to the produce of the country; the ardour of the sun is tempered by clouds, and fine showers refresh nature: hot summers are neither productive nor beneficial; the skies are cloudless, and weeks elapse without a shower; men and animals sink beneath the ardour of the sun, the grass is scorched, the corn thin and scanty, and the produce of the orchard and kitchen-garden coddled.

The mean temperature of the autumnal months, September, October, November, is 50°·4; the average power of the winds from all the quarters is in September 1·3, in October 1·2, and in November 1·3. In September the E. wind is again equal to the W. wind, both in power and in the number of times it blows; as is also the S. wind to the N. The most powerful winds are from the S.W., but they do not rise to a gale. In October the S. wind is equal to the N. wind; the winds from the S.S.W. to W. are as those from the N.N.E. to E., as 2 to 1; the E. wind is calm; violent squalls come from the S. and S.S.W. with heavy falls of rain: gales of great power occasionally blow; one of the most formidable happened on the 28th of the month 1838; the direction of the wind was S.W. November* on an average is calm, but the month seldom passes without a violent gale from some one point of the compass; one of the most remarkable was in 1836; heavy squalls from the S.W. set in on the 27th of the month; on the 28th the wind rose to a gale, with much scud and a high temperature; and on the 29th, between 11 A.M. and 2 P.M., it increased to a hurricane; its direction was then W. and W.N.W.; in 2½ hours the barometer rose 0·54 in.; thousands of trees were destroyed, houses were unroofed, and even solid buildings felt its effects; it passed over Ireland, the south of Britain, and the north of France: lightning is usually seen during the autumnal and winter gales. The month of September wavers between summer and autumn; its temperature may rise to 80°, but it never recedes below the freezing-point, although the thermometer on the *surface* of the ground frequently descends below it: the night temperature of September is nearly equal to that of June, but the day temperature is very much diminished. When September partakes of the character of summer, it is warm, calm and serene; when of autumn, it is cold, windy and rainy: thunder is frequently heard in September. In October the average number of frosty nights is 1·7; the day temperature declines rapidly, and heavy rains fall†. The greatest average amount of rain for the year falls in October: snow is not uncommon in this month; in the year 1819 and 1836 snow covered

---

* This refers to the east coast.

† For the average quantity of rain which falls in every month, see Manual of Barometer, p. 30. Second Edition.

the ground to the depth of 6 or 7 inches on the level. In November the average number of frosty nights is 6; the greatest number, 16, occurred in 1842: at the commencement of November there is much fine serene weather; towards the end it becomes mild and stormy: in the autumn the Stratus cloud is common, and the copious dews of this season yield a large amount of moisture. Fogs in November, near the metropolis, are now of rarer occurrence; the cause may be the better drainage and the enormous consumption of gas.

The foregoing summary shows that the climate of the south-eastern parts of England has a range of temperature equal to 100° (from − 4° to 95°), but that from the locality of the country the distribution of the heat is so variable throughout the year that it sometimes experiences the cold of Russia and the heat of India, and at other times the winters are a perpetual spring, and the summers so wet and cloudy, that the commonest fruits cannot ripen. The many years of want and famine which stand recorded in our ancient chronicles, lead to the inference that this state of climate has always obtained; for although the cultivation of vineyards is another fact recorded, yet the flavour of a vintage which suited the palate of a people whose sovereign's maids of honour at a much later period breakfasted upon herrings and beer, is no proof that the climate was sufficiently constant in the distribution of its mean annual amount of heat to produce wines comparable to those of France or Germany, or that could be tolerated by the most unrefined taste of the present times. Beyond the mere fact of a vintage, there is no record of productions indigenous to a settled climate having become extinct; on the contrary, as the intercourse with other nations became extended, we read of the introduction of trees, fruits and vegetables which intellect and skill could scarcely naturalize. The habits and customs of a high state of civilization are sufficient to account for the apparently less physical power of the present race of men; but there is no doubt that if it were imperative to restore the endurance and fatigues of a past barbarism, it would be found that a deteriorated climate had neither weakened nor destroyed that energy of national character, the spirit of which was "*vidi, vici.*" It is this energy now directed to commercial enterprise that chases famine from our shores; it searches every quarter of the globe, collects the produce of every climate, and thus our boards are spread with the necessaries and luxuries of life. The effects of a changeable climate on individual health must be our own care; in England, scattered throughout the year, are periods of very lovely weather interspersed with other periods, which even in summer may be termed inclement; knowledge and prudence must teach us to enjoy the one, and guard against the other. When the temperature falls below 55°, we should light our fires, more especially in rainy weather in the summer season. We should avoid the chill of grass from radiation, and screen ourselves from the cold of evaporation in spring (caused by the East wind), the more insidious because frequently accompanied by sunshine; and, above all, in this age of ventilation, we should shun all drafts of open doors and windows. With regard to dress, it must be regulated by the weather, and therefore by the thermometer.

Table of the Mean Temperature for every day in the year 1815–

Day of the month.	January.	February.	March.	April.	May.	June.
1.	36°·53	37°·14	40°·22	44°·26	52°·01	57°·10
2.	35·39	36·94	41·07	45·08	52·62	58·43
3.	34·97	37·30	42·04	45·42	52·81	58·68
4.	36·05	37·45	40·46	45·02	53·06	57·78
5.	35·64	38·14	40·09	45·36	53·51	57·75
6.	35·69	38·29	40·04	45·95	52·87	57·51
7.	35·52	38·64	40·83	45·70	53·27	57·90
8.	34·22	38·86	40·88	45·95	53·35	58·18
9.	34·28	39·18	40·31	45·48	51·65	58·40
10.	35·78	38·81	41·01	45·16	52·19	58·48
11.	35·62	38·05	41·05	44·84	52·03	58·96
12.	35·34	38·10	41·85	45·45	52·76	59·71
13.	35·85	37·82	42·02	46·54	52·35	60·33
14.	37·12	38·69	42·81	46·10	*51·64	61·08
15.	35·06	39·19	42·79	46·49	52·68	60·01
16.	35·12	38·87	42·91	46·57	53·92	60·10
17.	36·67	38·29	42·36	46·07	53·81	60·63
18.	36·13	39·03	42·42	45·57	53·87	60·36
19.	36·09	39·18	42·28	46·17	53·98	60·11
20.	35·50	38·68	42·81	47·10	54·20	60·92
21.	36·36	39·89	42·47	47·61	54·18	60·47
22.	37·72	40·05	42·69	48·28	54·33	60·61
23.	37·92	40·01	42·44	48·85	55·17	60·32
24.	38·39	40·00	42·23	48·73	55·84	60·50
25.	38·49	40·40	41·86	48·35	55·24	60·87
26.	38·94	39·99	41·70	49·02	55·03	61·17
27.	38·52	39·57	43·17	48·84	54·58	61·76
28.	38·06	39·76	43·95	49·30	55·31	61·89
29.	38·07	……	44·07	49·62	55·62	60·96
30.	37·46	……	44·16	50·50	55·33	61·30
31.	37·95	……	44·02	……	56·86	……
Means..	36·47	38·78	42·04	46·78	53·74	59·74

---

* Concerning the decrease of the mean daily temperature from the 12th to the 14th of May, see Humboldt's 'Cosmos,' vol. i. page 121. Bohn's edition.

for Greenwich, Kent, on an average of 35 *years:*
1849.

July.	August.	September.	October.	November.	December.	Day of the month.
60°·38	62°·79	59°·61	54°·20	46°·94	43°·71	1.
61·65	63·04	59·56	54·41	46·67	42·63	2.
62·19	63·02	59·33	53·61	46·47	41·47	3.
63·17	62·92	59·77	54·38	45·27	41·59	4.
63·59	62·68	59·15	53·22	44·73	41·89	5.
62·79	63·00	59·09	52·70	45·91	41·03	6.
62·02	62·85	58·57	53·32	45·92	40·59	7.
62·80	62·28	59·33	52·90	44·30	40·82	8.
61·40	62·28	58·38	51·80	43·09	40·05	9.
62·26	62·75	58·78	52·42	44·28	39·83	10.
62·69	62·73	58·23	53·20	45·13	39·07	11.
63·28	62·59	57·66	51·94	44·18	38·97	12.
62·91	62·00	57·28	50·91	43·97	39·83	13.
63·08	62·02	57·65	49·80	43·26	39·45	14.
63·57	61·60	58·46	50·11	42·97	40·03	15.
62·87	62·87	58·83	49·97	42·66	40·27	16.
63·65	62·53	58·75	49·63	42·05	40·07	17.
63·48	62·38	57·28	48·96	43·28	40·37	18.
62·11	61·97	56·56	50·01	42·46	40·58	19.
61·62	61·19	55·86	49·80	42·34	40·14	20.
62·17	61·37	55·24	49·36	43·34	39·12	21.
61·39	60·84	55·78	49·02	42·62	38·22	22.
61·79	61·43	55·49	49·64	42·53	38·44	23.
61·97	60·57	56·08	48·70	41·82	37·62	24.
63·14	60·69	55·93	47·97	40·92	37·11	25.
62·16	60·64	55·86	46·59	41·30	36·33	26.
62·45	61·25	54·67	47·20	40·85	36·23	27.
62·92	60·95	54·23	47·51	42·27	35·56	28.
62·98	60·94	53·99	46·45	43·75	35·91	29.
62·29	60·94	53·51	46·20	43·31	37·56	30.
62·82	59·77	……	46·80	……	37·27	31.
62·47	61·90	57·30	50·41	43·62	39·41	Means.

Mean temperatures of the seasons, divided into periods of five years, for Greenwich, Kent, for 35 *years, from* 1815 *to* 1849.

Date.	Spring.		Summer.		Autumn.		Winter.	
	Mar. Apr. May.		June. July. Aug.		Sept. Oct. Nov.		Dec. Jan. Feb.	
	°	°	°	°	°	°	°	°
1815.	50·03	47·93	62·60	61·99	49·87	50·49	39·35	38·36
1816.	45·48		58·37		48·25		36·63	
1817.	45·45		60·30		49·87		39·60	
1818.	48·58		65·60		54·62		37·02	
1819.	50·13		63·27		49·83		39·20	
1820.	47·62	47·92	60·48	61·01	48·37	51·49	34·68	37·96
1821.	47·74		59·37		53·78		37·68	
1822.	50·25		63·10		53·17		42·40	
1823.	47·55		60·35		49·33		34·83	
1824.	46·48		61·58		52·51		40·15	
1825.	47·65	47·86	62·57	62·16	51·10	50·41	40·08	38·91
1826.	47·97		65·92		51·13		38·43	
1827.	48·77		60·93		51·55		36·04	
1828.	48·76		61·59		51·27		41·86	
1829.	46·17		59·81		47·02		38·12	
1830.	49·83	48·25	59·50	60·93	50·04	50·52	32·87	38·28
1831.	48·92		62·58		51·64		36·92	
1832.	46·50		60·97		50·72		38·52	
1833.	47·39		59·25		49·08		39·42	
1834.	48·62		62·34		51·12		43·69	
1835.	47·40	45·28	62·46	61·35	49·97	49·41	39·96	37·64
1836.	46·79		61·73		48·10		36·53	
1837.	41·95		61·42		49·24		39·20	
1838.	45·63		60·52		49·04		34·26	
1839.	44·68		60·63		50·77		38·27	
1840.	47·30	48·58	60·87	61·00	47·70	49·87	38·94	37·95
1841.	50·82		58·91		50·72		33·87	
1842.	48·44		64·11		48·85		37·59	
1843.	48·00		60·66		51·14		39·94	
1844.	48·31		60·44		50·51		39·41	
1845.	43·96	47·39	59·86	61·56	49·52	50·73	34·66	38·67
1846.	48·69		64·81		52·30		42·77	
1847.	47·48		61·88		50·95		34·63	
1848.	49·38		60·40		50·00		39·64	
1849.	47·47		60·84		50·91		41·62	

Mean temp. Spring...... 1815–1849 ...... 47°·55
" " Summer ... 1815–1849 ...... 61·43
" " Autumn ... 1815–1849 ...... 50·42
" " Winter ... 1815–1849 ...... 38·22

The annual mean from 1815 to 1849, period of 35 years, = 49°·40.

The preceding table, p. 52, is the mean of every three months, each three months constituting a season, and each season being grouped into five yearly periods : these periods differ very little among each other in the mean, if we except the spring quarters from 1835 to 1839, where a defalcation of temperature of very nearly 3° occurs. This period of cold appears, however, to be the effect of a necessary compensation, as how much soever it may seem in excess, it does not disturb the mean temperature of the climate.

Table of the greatest and least observed heights of the Thermometer, also of the greatest annual range, and annual mean temperatures, from observations made at Greenwich, Kent, 1807 *to* 1849.

Date.	Greatest heat.	Least heat.	Greatest annual range.	Mean heat for each year.	Date.	Greatest heat.	Least heat.	Greatest annual range.	Mean heat for each year.
1807.	78°·0	13°·0	65°·0		1829.	80°·0	15°·0	65°·0	46°·77
1808.	95·0	15·0	80·0		1830.	87·0	10·5	76·5	48·34
1809.	79·0	18·0	61·0		1831.	80·0	19·0	61·0	50·62
1810.	78·0	13·0	65·0		1832.	80·1	21·0	59·1	49·10
1811.	80·0	14·0	66·0		1833.	81·5	20·5	61·0	49·01
1812.	79·0	17·0	62·0		1834.	86·1	23·4	62·7	51·10
1813.	80·0	19·0	61·0		1835.	86·2	17·2	69·0	49·51
1814.	89·0	14·0	75·0		1836.	86·5	12·6	73·9	48·69
1815.	78·0	15·0	63·0	50°·11	1837.	82·4	16·0	66·4	48·06
1816.	77·0	6·0	71.0	47·16	1838.	81·5	— 4·0	85·5	47·12
1817.	85·0	22·0	63·0	48·68	1839.	79·0	20·5	58·5	48·71
1818.	93·0	19·0	74·0	51·54	1840.	81·5	14·6	66·9	48·06
1819.	81·0	13·0	68·0	50·51	1841.	80·7	5·4	75·3	49·23
1820.	86·0	3·0	83·0	48·13	1842.	90·2	23·0	67·2	50·13
1821.	80·0	19·0	61·0	49·98	1843.	87·5	19·7	67·8	49·93
1822.	87·0	18·0	69·0	51·41	1844.	83·8	15·6	68·2	48·72
1823.	77·0	8·5	68·5	48·68	1845.	83·0	6·2	76·8	47·68
1824.	85·0	24·0	61·0	50·38	1846.	90·2	18·4	71·8	51·47
1825.	91·5	24·0	67·5	50·25	1847.	85·2	11·0	74·2	49·46
1826.	87·0	9·1	77·9	50·90	1848.	84·2	16·6	67·6	49·94
1827.	84·0	12·0	72·0	49·55	1849.	83·0	18·3	64·7	49·75
1828.	82·0	20·0	62·0	50·86					

A Table of the mean of the maxima and minima temperatures, together with the mean temperature and the mean diurnal variation for every month of the year, for Greenwich, Kent, on an average of 35 *years,* 1815 *to* 1849.

Month of the year.	Mean of the lowest temperature (by night) for each month.	Mean temperature for each month.	Mean of the highest temperature (by day) for each month.	Mean daily variation for each month.
January ...	32°·28	36°·46	40°·64	8°·36
February...	33·76	38·80	44·01	10·25
March......	35·73	42·04	48·52	12·79
April	38·72	46·78	54·99	16·27
May	44·94	53·74	62·55	17·61
June	50·61	59·74	68·91	18·30
July	53·68	62·47	71·40	17·72
August ...	53·38	61·90	70·20	16·82
September	49·42	57·30	65·14	15·72
October ...	44·08	50·41	57·00	12·92
November	38·71	43·62	48·40	9·69
December	35·36	39·41	43·75	8·39

In January the mean of the lowest temperature at night is rather higher than 32°; the mean of the highest by day is 40°·6; the mean diurnal variation is a little more than 8°. This is the coldest month of the year.

In February the mean of the lowest temperature rises 1°·5; the mean of the highest by day rises nearly 3°·5; the mean diurnal variation is 10°·25.

In March the sun's altitude has increased 20 degrees; the days and nights are equal; the mean of the lowest temperature, however, rises but 3°·5, while the mean of the highest by day has risen 8°.

In April the mean of the lowest temperature by night remains low, the increase being but 6°·5 above that of January, the mean highest by day having risen since January, 14°.

In May the sun has risen 40 degrees, and its influence is seen in the mean of the highest temperature by day, which now rises to 62°·55, and the mean of the lowest by night to 44°·94.

In June, the period of the solstice, the days are at their longest, and the mean of the highest temperature by day is nearly 69°; the mean of the lowest by night rises to 50°·6, and the mean diurnal variation reaches its maximum, amounting in this month to 18°·3.

In July the mean of the highest temperature by day arrives at its maximum, 71°·4; the mean of the lowest by night is also at its maximum, being 53°·7; the mean diurnal variation now decreases to 17°·7.

In August the mean of the highest temperature by day decreases only 1°·2 upon that of July, and the mean of the lowest temperature decreases from that of the same month only 0°·25; the mean heat of the two months differ only 0°·5; so that July and August may be considered to have the same temperature, and to constitute the summer.

In September there is a fall of 6° in the mean of the highest temperature by day, and of 4° in the mean of the lowest by night. The mean temperature on the day of the autumnal equinox is above 13° higher than that on the day of the vernal equinox. The mean of the *minima* by night of *September* corresponds very nearly with the mean of the *maxima* by day of *March*.

In October the mean of the highest temperature by day has decreased 14° since July, and the mean of the lowest by night 10°. The mean temperature of this month is about 50°, rather above the mean heat of the whole year.

In November the days are short, and the mean of the highest temperature by day has lost 9° of heat since October, and the mean of the lowest by night is depressed to 38°·7: winter now commences.

In December the mean of the highest temperature by day is 43°·75; the mean of the lowest by night has fallen to 35°·4. The sun's meridian altitude at Greenwich on the day of the solstice is only 15 degrees; the mean heat of the month rises no higher than 39°·4; and the mean diurnal variation is reduced to 8°.

A Synoptical Table of Mean Temperatures, &c.

	Mean temperature. 1815 to 1849.	Highest mean. 1815 to 1849.	Lowest mean. 1815 to 1849.	Greatest variation in the mean.	Highest temp. recorded by self-registering therm. 1815 to 1849.	Lowest temp. recorded by self-registering therm. 1815 to 1849.	Mean temp. at 9 A.M. 1842 to 1849.	Mean temp. of dew-point at 9 A.M. 1842 to 1849.	Mean temp. at 3 P.M. 1842 to 1849.	Mean temp. of dew-point at 3 P.M. 1842 to 1849.	Mean of terrestrial rad. by therm. on the ground. 1830 to 1842.	Mean of terrestrial rad. by therm. in parabolic reflector. 1842 to 1849.
January	36°·46	44°·28	28°·28	16°·00	56°·6	− 4°·0	37°·83	35°·91	41°·33	37°·49	29°·8	30°·3
February	38·80	43·98	32·33	11·65	62·1	+ 6·0	37·38	34·53	42·36	36·14	30·9	28·7
March	42·04	47·10	35·37	11·73	73·0	12·8	40·80	36·60	46·86	37·60	32·8	30·3
April	46·78	50·90	40·38	10·52	77·0	21·1	47·37	41·73	53·52	42·67	35·2	34·3
May	53·74	57·95	48·81	9·14	84·2	27·0	55·59	48·07	61·17	48·42	41·1	40·5
June	59·74	65·12	54·45	10·67	88·5	36·4	61·46	53·04	67·01	53·48	48·1	46·1
July	62·47	68·55	58·78	9·77	93·0	39·5	63·58	55·30	68·26	56·76	51·0	49·4
August	61·90	67·28	57·70	9·58	90·2	36·5	61·55	54·94	67·15	55·32	51·0	48·7
September	57·30	61·40	53·70	7·70	85·0	32·1	57·28	52·66	64·17	53·44	45·4	44·7
October	50·41	55·50	44·20	11·30	75·5	25·1	50·21	47·57	55·36	48·03	40·6	39·1
November	43·62	49·85	38·70	11·15	63·0	20·4	43·85	41·83	47·72	43·14	36·0	35·4
December	39·41	44·50	32·32	12·18	58·5	10·5	38·57	36·73	41·72	38·01	32·1	30·6
Mean	49·39	....	....	....	....	....	49·62	44·91	54·72	45·86		

The 1st column shows the mean temperature of each month.
The 2nd column shows the *highest* mean temperature which each month has attained in the whole period.
The 3rd column shows the *lowest* mean temperature to which each month has been depressed in the whole period.
***Ex.*—In January the mean temperature is 36°·46, but it has risen once as high as 44°·28, and it has fallen once as low as 28°·28, &c.**

Printed by Richard and John E. Taylor, Red Lion Court, Fleet Street.