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I see Mr. Cayley has amended his paper of November 1844. If he would amend it a little further, it would not be amiss. He has now made p a prime number instead of any odd one: θ is made of the second instead of the general form. In the expression of $\phi_{,} x$, or rather $\phi\, x'$, he should have had the transformed function $x' = \frac{x}{\beta}$, not x, β a function of θ. Moreover,

$$\omega' = \frac{1}{p\beta}(\alpha\omega + \mathit{6}v), \qquad v' = \frac{1}{p\beta}\alpha'\omega + \mathit{6}'v).$$

Some other amendments are greatly wanted. When x has a determinate value, x' should have one also, since β is a known function of θ. And if we know what value to assign to x, we should have the value of x', which is the complete function. I have no room to enlarge, and as Mr. Cayley has done nothing which invalidates what I have done, it is unnecessary.

Gunthwaite Hall, Dec. 12, 1845.

VIII. *On some Points in the Meteorology of Bombay.* *By* Lieut.-Colonel SABINE, *R.A., F.R.S.**

[With a Plate.]

IN a communication which I had the honour to make to the Section at the York meeting of the British Association, on the subject of the meteorological observations made at Toronto in Canada in the years 1840 to 1842†, I noticed some of the advantages which were likely to result to the science of meteorology, from the resolution of the barometric pressure into its two constituents of aqueous and of gaseous pressure. It was shown that when the constituents of the barometric pressure at Toronto were thus disengaged from each other and presented separately, their annual and diurnal variations exhibited a very striking and instructive accordance with the annual and diurnal variations of the temperature. The characteristic features of the several variations when projected in curves were seen to be the same, consisting in all cases of a single progression, having one ascending and one descending branch; the epochs of maxima and minima of the pressures being the same, or very nearly the same, with those of the maxima and minima of temperature; and the correspondence in other respects being such as to manifest the existence of a very intimate connexion between the periodical variations of the temperature, and those of the elastic forces of the air and vapour. The curve of gaseous pressure was inverse in respect to the other two; that is to say, as the temperature increased the elastic force of the vapour increased also, but that of the air diminished, and *vice versâ*; and this was the case both in the annual and the diurnal variations.

* Communicated to the Mathematical and Physical Section of the British Association for the Advancement of Science, at the Cambridge Meeting, 1845.

† See Phil. Mag., vol. xxvi. p. 94.

Such being the facts, I endeavoured to show, in the case of the diurnal variations, that the correspondence of the phænomena of the temperature and gaseous pressure might be explained, in accordance with principles which had been long and universally admitted in the interpretation of other meteorological phænomena, by the suppositions,—of an extension in height and consequent overflow in the higher regions of the atmosphere of the column of air over the place of observation, during the hours of the day when the surface of the earth was gaining heat by radiation,—and of a contraction of the column during the hours of diminishing temperature, and consequent reception of the overflow from other portions of the atmosphere, which in their turn had become heated and elongated.

According to this explanation there should exist, during the hours of the day when the temperature is increasing,—1st, an *ascending current* of air at the place of observation, of which the strength should be measured by the amount of the increments of temperature corresponding to given intervals of time; and 2nd, a *lateral influx of air at the lower parts of the column*, of proportionate velocity, constituting a *diurnal variation in the force of the wind* at the place of observation, which should also correspond with the variations of the temperature in the epochs of its maximum and minimum, and intermediate gradation of strength. The anemometrical observations at Toronto were shown to be in agreement with the view which had been then taken, confirming the existence of a diurnal variation in the force of the wind, corresponding in all respects with the variation of the temperature.

Admitting the explanation thus offered to be satisfactory in regard to the diurnal variations, it was obvious that the correspondence of the annual variations of the temperature and pressures might receive an analogous explanation.

A comparison of the results of the observations at Toronto with those of the observations of M. Kreil at Prague in Bohemia, (published in the *Mag. und Met. Beob, zu Prag*, and in the *Jahrbuch für Prag*. 1843,) showed that the characteristic features of the periodical variations at Toronto were not peculiar to that locality, but might rather be considered as belonging to stations situated in the temperate zone and in the interior of a continent. The annual and diurnal variations at Prague were also single progressions, and the same correspondence was observable between the variations of the temperature and of the gaseous pressure.

The publication of the volume of magnetical and meteorological observations made at Greenwich in 1842, which took place shortly after the meeting of the Association at York, enabled me to add a postscript to the printed statement of my communication in the annual volume of the Association Reports, showing the correspondence of the results at Greenwich with the relations which had been found to exist in the periodical march of the phænomena at Toronto and at Prague.

From the concurrence of these three stations, it was obvious that a considerable insight had been obtained into the laws which regulate the periodical variations in the temperate zone, and into the sequence of natural causes and effects, in accordance with which the annual and diurnal fluctuations of the elastic forces of air and vapour at the surface of the earth depend on the variations of temperature: and from these premises it was inferred, that the normal state of the diurnal variations of the pressures of the air and vapour and of the force of the wind, in the temperate zone, might be regarded as that of a single progression with one maximum and one minimum, the epochs of which should nearly coincide with those of the maximum and minimum of temperature*.

That exceptions should be found to this state of things in particular localities in the temperate zone was far from being impro-

* Since this communication was read at Cambridge I have received from M. Dove a copy of a paper read to the Academy of Berlin, entitled 'Ueber die periodischen Aenderungen des Druckes der Atmosphäre im Innern der Continente,' in which the remarkable facts are stated, that at Catherinenbourg and Nertchinsk (on the mean of several years), and at Barnaoul (in the years 1838 and 1840), the mean diurnal *barometric* curve itself exhibits but one maximum and one minimum in the twenty-four hours; the maximum coinciding nearly with the coldest, and the minimum with the hottest hours of the day. At these stations therefore, and in the years referred to, the forenoon maximum disappeared, and the barometric curve assimilated in character to the curve of the dry air in other places in the temperate zone. These stations are situated far in the interior of the greatest extent of dry land on the surface of our globe, and at a very great distance from an expanse of water, from whence vapour can be supplied. The diminished pressure of the dry air produced by the ascending current and overflow as the temperature of the day increases, is not therefore compensated by an increased elasticity of vapour, and the curve of the diurnal variation of the barometer approximates to the form assumed when the elasticities of the vapour at the several hours of observation are abstracted. This assimilation in character of the barometric and (inferred) gaseous curves, which is thus found to take place in cases where, from natural causes, the influence of the vapour is greatly lessened, appears a confirmation of the propriety of separating the effects of the elastic forces of the dry air and vapour in their action on the barometer.

M. Dove considers that the single progression of the diurnal barometric curve, which takes place at the three Asiatic stations referred to in this note, is characteristic of a true continental climate. It is, without doubt, characteristic of an extreme climate, and as such is highly instructive. There appears reason to doubt whether an extreme climate of corresponding character exist at all in the temperate latitudes of the continent of America.

If, however, we examine the record of the observations made hourly in the year 1842 at Catherinenbourg, Barnaoul and Nertchinsk, in the 'Annuaire Magnétique et Météorologique de Russie,' we find that at Catherinenbourg in that year the barometer exhibits a double progression, but that the morning maximum, which occurs at the observation hour of $8^h\ 22^m$ A.M., exceeds the antecedent minimum only by a quantity less than 0·003 in. At Barnaoul there is also a double progression in the barometric mean in that year, the morning maximum being still small, and taking place between the observation hours of $9^h\ 54^m$ and $10^h\ 54^m$ A.M. At Nertchinsk also there is a morning maximum occurring at the observation hour of $9^h\ 17^m$ A.M. In all the three cases the double progression shown by the barometer disappears wholly in the curve of the dry air, which curve exhibits at these three stations, as well as at Toronto, Prague and Greenwich, but one maximum and one minimum in the twenty-four hours. At the three stations of extreme dryness cited by M. Dove, therefore the vapour was still sufficient to impart, in the year 1842 at least, a double progression to the diurnal variation of the barometer; but the hour of the morning maximum was earlier than where the increase of vapour, as the day advances, is greater.

bable; it could not be expected that the influences of temperature should always be so simple and direct as they appeared to be at Toronto; and a more complex aspect of the phænomena might particularly be looked for, where a juxtaposition should exist of columns of air resting on surfaces differently affected by heat (as those of land and sea), and possessing different retaining and radiating properties. In such localities *within the tropics*, the well-known regular occurrence of land and sea breezes for many months of the year made it obvious that a double progression in the diurnal variation of the force of the wind must exist, and rendered it highly probable that a double progression of the gaseous pressure would also be found. It was therefore with great pleasure that I received, through the kindness of Dr. Buist, a copy of the monthly abstracts of the two-hourly meteorological observations, made under that gentleman's superintendence at the observatory at Bombay in the year 1843; accompanied by a copy of his meteorological report for that year, possessing a particular value, in the full account which it gives of the periodical variations of the wind, and in the means which it thereby affords of explaining the diurnal variation of the gaseous pressure. This pressure presents at Bombay an aspect at first sight more complex than at the three above-named stations in the temperate zone, but I believe it to be equally traceable to variations of the temperature, and to furnish a probable type of the variations at intertropical stations similarly circumstanced in regard to the vicinity of the sea.

The observatory at Bombay is situated on the island of Colabah, in N. lat. 18° 54′ and E. long. 72° 50′ at an elevation of thirty-five feet above the level of the sea. In the copy of the observations received from Dr. Buist, the monthly abstracts are given separately for each month, of the standard thermometer,—of the wet thermometer, and of its depression below the dry,—and of the barometer. In Table I. I have brought in one view the thermometrical and barometrical means at every second hour, and the mean tension of the vapour and mean gaseous pressure at the same hours. The tension of the vapour at the several observation hours has been computed from the *monthly means*, at the same hours, of the wet thermometer and of its depression below the dry thermometer. The values are consequently somewhat less than they would have been, had the tension been computed from each individual observation of the wet and dry thermometers, and had the mean of the tensions thus obtained been taken as the value corresponding to the hour. The difference is however so small, that for the present purpose it may be regarded as quite insignificant. It would not amount in a single instance to the hundredth part of an inch; and as in every instance the difference would be in the same direction, the *relative* values, which are those with which we are at present concerned, would be scarcely sensibly affected. The pressures of the dry air (or the gaseous pressures) are obtained by deducting the tension of the vapour from the whole barometric pressure.

TABLE I.

Bombay, 1843.—Mean Temperature, Mean Barometric Pressure, Mean Tension of Vapour, and Mean Gaseous Pressure at every second hour.

Hours of Mean Bombay Time. Astronomical Reckoning.	Temperature.	Barometer.	Tension of Vapour.	Gaseous Pressure.
	°	in.	in.	in.
18	78·4	29·805	0·750	29·055
20	79·6	29·840	0·766	29·074
22	81·8	29·852	0·771	29·081
0	83·2	29·817	0·768	29·049
2	84·1	29·776	0·795	28·981
4	83·9	29·755	0·800	28·955
6	82·3	29·774	0·802	28·972
8	81·2	29·806	0·801	29·005
10	80·3	29·825	0·780	29·045
12	79·8	29·809	0·775	29·034
14	79·4	29·786	0·766	29·020
16	78·9	29·778	0·761	29·017
Mean of the year ...	81·1	29·802	0·780	29·022

The sun is vertical at Bombay twice in the year, viz. in the middle of May and towards the end of July. The rainy season sets in about the commencement of June (in 1843 on the 2nd of June), and terminates in August, but with heavy showers of no long duration continuing into September. During the rainy season, and in the month of May which immediately precedes it, the sky is most commonly covered with clouds, by which the heating of the earth by day, and its cooling at night by radiation, are impeded, and the range of the diurnal variation of the temperature is greatly lessened in comparison with what takes place at other times in the year. The strength of the land and the sea breezes in those months is also comparatively feeble, and on many days the alternation of land and sea breeze is wholly wanting. During the months of November, December, January and February, the diurnal range of the temperature is more than twice as great as in the rainy season, and the land and sea breezes prevail with the greatest regularity and force.

In addition to the monthly tables, we may therefore advantageously collect in one view, for purposes of contrast, the means of the months of May, June, July and August, as the season when the sky is generally clouded,—and of the months of November, December, January and February, as the season of opposite character, when the range of the diurnal temperature is greatest, and the land and sea breezes alternate regularly, and blow with considerable strength. These seasons are contrasted in Table II.

If we direct our attention to the diurnal variations, commencing with those of the temperature, we find them exhibiting a single progression, having a minimum at 18^h and a maximum at 2^h; the average difference between the temperature at 18^h and 2^h being $7^\circ{\cdot}77$

in the clear season, 3°·71 in the clouded season, and 5°·7 on the mean of the whole year.

When however we direct our attention to the gaseous pressure, we perceive, very distinctly marked, the characters of a double progression, having one maximum at 10^h and another at 22^h; one minimum at 4^h and another at 16^h. The double progression is exhibited both in the clouded and in the clear seasons, with a slight difference only in the hours of maxima; the principal maximum in the cloudy season being at 20^h instead of 22^h, and the inferior maximum in the clear season being at 12^h instead of 10^h. The range of the diurnal variation, like that of the temperature, is more than twice as great in the clear as in the clouded season, marking distinctly the connexion subsisting between the phænomena of the temperature and of the gaseous pressure.

Table II.

Bombay, 1843.—Comparison of the Temperature and of the Gaseous Pressure in the months of May, June, July and August, when the sky is usually covered with clouds; and in November, December, January and February, when the sky is usually clear.

Hours of Mean Time at Bombay. Astronomical Reckoning.	Temperature.		Gaseous Pressure.	
	November, December, January and February.	May, June, July and August.	November, December, January and February.	May, June, July and August.
	°	°	in.	in.
18	74·1	81·9	29·344	28·782
20	75·3	83·1	29·368	28·806
22	78·1	84·3	29·391	28·798
0	80·8	85·1	29·353	28·782
2	81·9	85·6	29·230	28·746
4	81·7	85·4	29·195	28·724
6	79·6	84·3	29·199	28·740
8	78·4	83·4	29·248	28·754
10	76·9	83·0	29·308	28·800
12	76·2	82·7	29·316	28·775
14	75·7	82·6	29·295	28·754
16	74·9	82·2	29·285	28·753
Means	77·8	83·7	29·298	28·763

If we now turn our attention to the phænomena of the direction and force of the wind, we find by Dr. Buist's report, that for 200 days in the year there is a regular alternation of land and sea breezes. The land breeze springs up usually about 10^h, or between 10^h and 14^h, blows strongest and freshest towards daybreak, and gradually declines until about 22^h, at which time the direction of the aërial currents changes, and there is generally a lull of an hour or an hour and a half's duration. The sea breeze then sets in, the ripple on the surface of the water indicating its commencement being first observed close in shore, and extending itself gradually out to sea. The sea breeze is freshest from 2^h to 4^h, and progressively declines in the evening hours.

The diurnal variation in the force of the wind during these 200 days is therefore obviously a double progression, having two maxima and two minima; one maximum at or near the hottest, and the other at or near the coldest hour of the day,—being the hours when the difference of temperature is greatest between the columns of air which rest respectively on the surfaces of land and sea; and two minima coinciding with the hours, when the surface temperature over the land and over the sea approaches nearly to an equality.

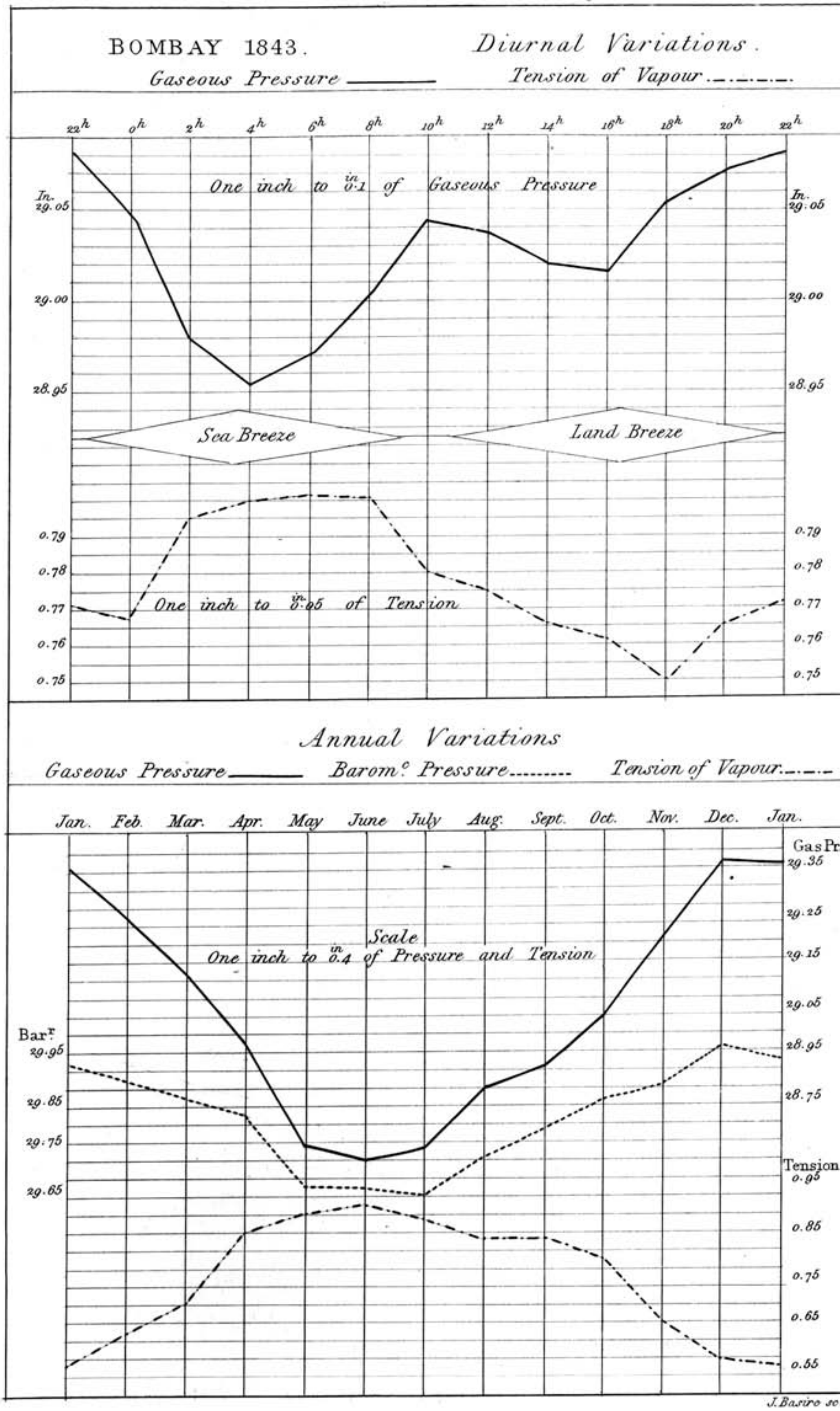
In the remaining portion of the year the diurnal range of the temperature is most frequently insufficient to produce that alternation in the direction of the wind, which prevails uninterruptedly during the larger portion. There appears however to have been only one month, viz. July, in the year 1843, in which there were not some days in which the alternation of land and sea breezes was perceptible. The causes which produce the alternation are not therefore wholly inoperative, though the effects are comparatively feeble during the clouded weather which accompanies the south-west monsoon*.

If we now view together the diurnal variations of the wind and gaseous pressure, as shown in Plate I., we find a minimum of pressure coinciding with the greatest strength of the sea breeze; a second minimum of pressure coinciding with the greatest strength of the land breeze; and a maximum of pressure at each of the periods when a change takes place in the direction of the aërial currents; or, otherwise stated, we find a decrease of pressure coincident with the increase of strength both of the land and sea breezes, and an increase of pressure coincident with their decline in strength.

The facts thus stated appear to me to admit of the following explanation:—the diminution of pressure which precedes the minimum at 4^h is occasioned by the rarefaction and ascent of the column during the heat of the day, and its consequent overflow in the higher regions of the atmosphere, which is but partially counterbalanced in the forenoon by the influx of the sea breeze at the lower part of the column. Shortly after the hottest hour is passed, the overflow above and the supply below become equal in amount, and the diminution of pressure ceases. As the temperature falls towards evening, the column progressively contracts, when the influx from the sea breeze more than counterbalances the overflow, and the pressure again increases until a temporary equilibrium is restored, when the sea breeze ceases and the pressure is stationary.

As the night advances, the air over the land becomes colder than over the sea; the length of the column over the land contracts, and the air in its lower part becomes denser than in that over the sea: an interchange then commences of an opposite character to that which prevailed during the day. The outward flow is now from the *lower* part of the column, or from the land towards the sea,

* There are no data in Dr. Buist's report from which the diurnal variation in the force of the wind may be judged of in the days during the south-west monsoon, when no alternation takes place in its direction. It would seem probable that on such days the variation should be a single progression, weakest towards daybreak, and strongest about the hottest hour of the day.


BOMBAY 1843.
Diurnal Variations.
Gaseous Pressure
Tension of Vapour
22h 0h 2h 4h 6h 8h 10h 12h 14h 16h 18h 20h 22h
One inch to 0.1 in of Gaseous Pressure
In. 29.05
29.00
28.95
Sea Breeze
Land Breeze
0.79
0.78
0.77
0.76
0.75
One inch to 0.05 in of Tension
Annual Variations
Gaseous Pressure
Barom.c Pressure
Tension of Vapour
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan.
Gas Pr.
29.35
29.25
29.15
29.05
28.95
28.75
Scale
One inch to 0.4 in of Pressure and Tension
Bar.r
29.95
29.85
29.75
29.65
Tension
0.95
0.85
0.75
0.65
0.55
J. Basire sc.

causing the pressure to diminish over the land; it continues to do so until towards daybreak, when the strength of the land breeze is greatest, because the air over the land is then coldest in comparison with that over the sea. As the sun gains in altitude and the temperature of the day advances, the land heats rapidly; the density of the air over the land and sea returns towards an equality; the land breeze declines in strength, and the drain from the lower part of the column ceases to counterbalance the overflow which the land column is at the same time receiving in the higher regions; the pressure consequently having attained a second minimum at or near the hour of the greatest disproportion of temperature, again increases until the temperature and height of the column over the sea and land are the same, and the pressure again becomes stationary. But now the rarefaction of the column over the land continuing, its increase in height above the less heated column with which it is in juxtaposition, and its consequent overflow, occasion the pressure to decrease until the minimum at 4 o'clock is reached.

We have thus therefore at Bombay a *double progression of the diurnal variation of the gaseous pressure*; the principal minimum occurring at 4 o'clock in the afternoon, occasioned by an overflow from the column in the higher regions of the atmosphere; and the second minimum occurring at 18^h, occasioned by an efflux from the lower part of the column. The first minimum is similar to that which has been shown to take place at Toronto, Prague and Greenwich, and is similarly explained: the second minimum, which does not take place at the three above-named stations, is owing to the juxtaposition of the columns of air over the sea and land, which differ in temperature, and therefore in density and height, in consequence of their resting respectively on surfaces which are differently affected by heat.

Plate I. shows the curve of the gaseous pressure, and the curve of the elastic force of the vapour; and between them is placed a diagram illustrating the hours of prevalence and of the greatest strength of the land and sea breezes. At Toronto and at Greenwich the diurnal curve of the vapour is a single progression, having its maximum at or near the hottest hour of the day, and its minimum at or near the coldest hour. We perceive in the Plate which represents the phænomena at Bombay, the modification which takes place in consequence of the supply of vapour brought in by the sea breeze continuing until a late hour in the evening, and prolonging the period during which the tension is at or near its maximum. The minimum occurs as usual at or near the hour of the coldest temperature.

If, then, the explanation which I have offered to the Section, of the physical causes which produce the diurnal variation of the gaseous pressure at Bombay, be correct, the diurnal variation of the barometric pressure occurring there is also explained, since it is simply the combination of the two elastic forces of the air and of the vapour.

The solution of the problem of the diurnal variation of the barometer is therefore obtained by the resolution of the barometric pressure into its constituent pressures of vapour and air; since the physical causes of the diurnal variation of the component pressures have been respectively traced to the variations of temperature produced in the twenty-four hours by the earth's revolution on its axis, and to the different properties possessed by the material bodies at the surface of the globe in respect to the reception, conveyance, and radiation of heat.

Annual variation.—We now proceed to the annual variations, which are shown in the subjoined table.

TABLE III.

1843.	Temperature.	Vapour Pressure.	Gaseous Pressure.	Barometer.	Humidity.	Monthly Means greater (+) or less (—) than the Annual Means.		
						Temperature.	Vapour Pressure.	Gaseous Pressure.
January ...	76·4	0·578	29·352	29·930	67	−4·7	−0·202	+0·329
February ...	77·7	0·648	29·246	29·894	71	−3·4	−0·132	+0·223
March	79·7	0·710	29·128	29·838	74	−1·4	−0·070	+0·105
April	84·2	0·853	28·961	29·814	76	+3·1	+0·073	−0·062
May	85·9	0·921	28·743	29·664	78	+4·8	+0·141	−0·280
June.........	85·4	0·935	28·718	29·653	80	+4·3	+0·155	−0·305
July	82·1	0·896	28·737	29·633	85	+1·0	+0·116	−0·286
August	81·2	0·859	28·869	29·728	84	+0·1	+0·079	−0·154
September..	81·1	0·859	28·920	29·779	84	0·0	+0·079	−0·103
October ...	82·2	0·819	29·026	29·845	78	+1·1	+0·039	+0·003
November..	80·5	0·675	29·213	29·888	67	−0·6	−0·105	+0·190
December..	76·6	0·592	29·368	29·960	67	−4·5	−0·188	+0·345
	81·1	0·780	29·023	29·803	76			

We here perceive that the leading features of the phænomena are clearly analogous to those which have been seen to present themselves at Toronto, Prague and Greenwich; viz. a correspondence of the maximum of vapour pressure and minimum of gaseous pressure with the maximum of temperature,—and of the minimum of vapour pressure and maximum of gaseous pressure with the minimum of temperature; and a progressive march of the three variations from the minimum to the maximum, and back to the minimum again. The epochs, or turning-points of the respective phænomena, are not in every case strictly identical; but their connexion, which is the subject immediately before us, is most obvious.

We have thus a further illustration of the universality of the principle of the dependence of the regular periodical variations, annual as well as diurnal, of the pressures of the dry air and of the vapour, on those of the temperature*.

* In the tropics and in the temperate zone the heat of summer produces and accompanies a low gaseous pressure, and the cold of winter a high gaseous pressure. When we consider how large a portion of the northern hemisphere is occupied by land, which becoming greatly heated in summer rarefies the superincumbent atmosphere, causing it to overtop the adjacent less heated masses, and to overflow them, we should be led to expect that in parts of the Arctic Circle situ-

The humidity exhibits also a single progression; but may perhaps be rather characterized as evidencing a very dry season from November to February, and a very humid one from June to Septem-

ated to the north of the great continents, the gaseous pressure should be *increased* in summer, and that the curve of annual variation should become the converse of what it is in the lower latitudes. It appears from the meteorological observations made in 1843 by Messrs. Grewe and Cole, and presented to the British Association at the York meeting by Dr. Lee, that such is the case at Alten, near the north cape of Europe. The barometer and thermometer were observed three times a day, from October 1842 to December 1843 inclusive. The hours of observation were 9 A.M., 3 P.M. and 9 P.M. No hygrometric observations were made, but we are able to infer the approximate tension of the vapour from the record of the thermometer. The quarterly means of the barometer and thermometer in 1843 are as follows; the barometer being reduced to the level of the sea, and corrected for gravity:—

	Barometer. in.	Thermometer. °
December, January, February......	29·375	24 F.
March, April, May	29·948	27·7
June, July, August	29·905	52·4
September, October, November ...	29·716	34·2
Mean of the year	29·736	34·6

Assuming the humidity in each quarter of the year to be 75, or the vapour to be in each case three-fourths of that required for saturation at the respective temperatures, we should have the following gaseous pressures:—

	in.
Dcember, January, February	29·257
March, April, May	29·804
June, July, August	29·616
September, October, November, December ...	29·566
	29·561

It appears therefore that in the six summer months the mean barometric pressure exceeded that of the winter months by 0·381 inch; and the mean gaseous pressure of summer exceeded that of winter by about 0·3 inch. As in this case the curve of the gaseous pressure, as well as that of the aqueous vapour, accords in character with the curve of temperature, i. e. ascends with ascending temperature, and descends with descending temperature,—the barometric annual range is greater than the gaseous annual range, which is contrary to what takes place in the temperate and equatorial zones. It is not improbable that in the Antarctic Circle the phænomenon which we have just noticed as taking place in the Arctic Circle, viz. the summer increase of the gaseous pressure,—may not be found in the same degree, if at all; for the two hemispheres present a remarkable contrast in their respective proportions of sea and land, and the rarefaction of the atmosphere over the middle latitudes of the southern hemisphere during its summer must be greatly less than in the same latitudes of the northern hemisphere in the corresponding season. The barometrical observations made by Sir James Ross in summer in the Antarctic Circle accord with this inference; since after correcting them for the shortening of the column of mercury by the increased force of gravity in the high latitudes, and abstracting the small tension of vapour corresponding to the temperature, the mean gaseous pressure deduced from them, though nearly equal to the mean gaseous pressure of the year at Bombay, does not exceed it; whereas at Alten it is only in the winter months that the gaseous pressure descends so low as to approximate to the usual mean gaseous pressure of the tropical regions.

It is much to be desired that the zealous observers at Alten should observe the ber, the latter season being that of the rains. The average degree of humidity in the year is very slightly lower than either at Toronto or at Greenwich, but is still closely approaching to a value expressing the presence of three-fourths of the quantity of vapour required for saturation.

The mean gaseous pressure in 1843, derived from the two-hourly observations, appears to have been (29·023 + 0·025, an index correction which Dr. Buist gives as that of the barometer with which the observations were made =) 29·048 English inches; or, measured by the height of a mercurial column in the latitude of 45°, 28·988. The height above the sea is thirty-five feet, and the latitude 19° N.

The mean height of the barometer in the year 1843, derived from observations at every second hour, appears to have been (29·803 + 0·025 =) 29·828, or, with the correction applied for gravity, 29·768, the elevation being thirty-five feet above the sea. This is less than what is generally received as the average height of the barometer in the same latitude. From the careful comparison described in Dr. Buist's report of the standard barometer with several other barometers, there seems great reason to believe that the mean height shown by it must be a very near approximation at least to the true mean atmospheric pressure in the year 1843 at Bombay.

The mean height of the barometer in the four clouded months of May, June, July and August, is 29·667; and in the four clear months of November, December, January and February, 29·921. The mean vapour pressure in the same seasons is respectively 0·904 and 0·623, and the gaseous pressure consequently 28·763 and 29·298. There is therefore between the two seasons a difference of 0·535 in. of gaseous pressure, and of 5°·84 of temperature; the lowest pressure corresponding to the highest temperature, and *vice versâ.* If we may allow ourselves to make a rough proportion drawn from a single case, we may estimate a decrement of 0·1 in. of pressure to an increment of 1° F. The highest temperature and lowest pressure are accompanied for nearly the whole of the period by the southern monsoon; the lowest temperature and the highest pressure are accompanied by the northern monsoon.

The curves of the annual variation of the gaseous, barometric, and vapour pressures, which are represented in Plate I., show how much of the influence produced on the gaseous pressure, by the alternation of the overflow in the high regions of the atmosphere as either side of the equator becomes heated in its turn, is masked in the barometric curve by the combination in the latter of the vapour pressure, the variations of which take place throughout the year

wet thermometer at the same time as the barometer; the register would also be rendered much more complete by the addition of another observation-hour, about 6 A.M., which might not perhaps be inconvenient. The atmospheric pressure and the tension of vapour at or near the coldest hour of the twenty-four, are important data in meteorological discussions.

in the opposite direction to those of the gaseous pressure. From this cause the range of the barometric curve during the year is only 0·327 inch, whilst that of the gaseous pressure is 0·650 inch.

The analogy of the annual and diurnal variations, considered in respect to the explanation which has been attempted of the latter, is too obvious to be dwelt upon. The decreased gaseous pressure in the hot season is occasioned by the rarefaction of the air over the land whilst the sun is in the northern signs, and its consequent overflow in the higher regions, producing a return current in the lower strata; and the increased pressure in the cold season is occasioned by the cooling and condensation of the air, whilst the sun is on the south side of the equinoctial, and its consequent reception of the overflow in the upper strata from the regions which are then more powerfully warmed, and which is but partially counteracted by the opposite current in the lower strata.

In concluding this communication, I beg respectfully to submit to the consideration of the eminent meteorologists here present, that it is very important towards the progress of this science, that the propriety (in such discussions as the present) of separating the effect of the two elastic forces which are considered to unite in forming the barometric pressure, should be speedily admitted or disproved. The very remarkable fact recently brought to our notice by Sir James Ross, as one of the results of his memorable voyage, that the mean height of the barometer is full an inch less in the latitude of 75° S. than in the tropics, and that it diminishes progressively from the tropics to the high latitudes, presses the consideration of this point upon our notice; for it is either explained wholly or in greater part by the diminution of the vapour constituent in the higher latitudes, which diminution appears nearly to correspond throughout to the decrease of barometric pressure observed by Sir James Ross; or it is a fact unexplained, and I believe hitherto unattempted to be explained, on any other hypothesis, and of so startling a character as to call for immediate attention.

If, by deducting the tension of the vapour from the barometric pressure, we do indeed obtain a true measure of the pressure of the gaseous portion of the atmosphere, the variations of the mean annual gaseous pressure, which will thus be obtained in different parts of the globe,—and the differences of pressure in different seasons at individual stations,—may be expected to throw a much clearer light than we have hitherto possessed on those great aërial currents, which owe their origin to variations of temperature proceeding partly from the different angles of inclination at which the sun's rays are received, and partly from the nature and configuration of the material bodies at the surface of the earth: and a field of research appears to be thus opened by which our knowledge of both the persistent and the periodical disturbances of the equilibrium of the atmosphere may be greatly extended.