PHILOSOPHICAL TRANSACTIONS.

XV. *Discussion of Meteorological Observations taken in India, at various heights, embracing those at Dodabetta on the Neelgherry Mountains, at* 8640 *feet above the level of the sea. By Lieutenant-Colonel* W. H. Sykes, *F.R.S.*

Received January 12,—Read March 21, 1850.

In the year 1835 the Royal Society did me the honour to publish the results of six years' meteorological observations, taken by me on the elevated plateau of the Dukhun (Deccan) from 1825 to 1830, both years inclusive; my chief object being to illustrate the diurnal oscillations of the barometer as indicative of the periodic tides (if they may be so called) of the atmosphere. I showed that in many thousand observations, taken personally, there was not a solitary instance in which the barometer was not higher at 9—10 A.M. than at sunrise; and lower at 4—5 P.M. than at 9—10 A.M., *whatever the state of the weather or the indications of the thermometer or hygrometer might be*; nor was there a solitary instance in 1830, during which year only I took systematic night observations, and observed at the turning-points every five minutes, in which the maximum nocturnal tide was not higher at 9—10 P.M. than at 4—5 P.M. The 4—5 A.M. minimum tide was less regularly noticed than the other three tides; but nevertheless sufficiently often to render it perfectly clear, that in the twenty-four hours there were two minima as well as two maxima of pressure in twenty-four hours. I had the advantage at times of carrying on my observations in the six years, at a mean elevation of 1800 feet, simultaneously with observations made in Bombay at the level of the sea, and at Mahabuleshwur at 4500 feet above the sea. These simultaneous observations for limited periods led me to remark, that the amount or range of the diurnal oscillation between the maximum and minimum hours did not correspond at the different elevations. At the level of the sea in Bombay the range between 9—10 A.M. and 4—5 P.M., appeared generally to be less than the range between the same hours in Dukhun (Deccan) at 1800 feet above the sea; but at Mahabuleshwur, at 4500 feet, the range was *constantly* less than in Bombay or on the plateau of the Deccan. Not having had further means of prosecuting inquiry into the fact, it was with much interest I remarked that the orders of the Court of Directors of the East India Company had been carried out by the astronomer at Madras, and meteorological observations taken for a whole year at a

greater elevation above the sea-level, than had ever been attempted before in India. Observations so made were peculiarly acceptable to me, as they would subject the accuracy of my own observations to an additional test, and would supply the means of investigating the supposed diminished diurnal oscillation of the barometer in relation to elevation above the sea. At the present time I have the further advantage of being enabled to subject my Deccan observations to the test of comparison with recent observations at the Bombay and Madras Observatories, taken chiefly with a view to determine the amount of the hourly and diurnal changes of the barometer. Those for Madras are from the years 1841 to 1845, both inclusive*: for Bombay, I am sorry to say, the records which have reached my hands are for more limited periods. Dr. Buist, LL.D., while in temporary charge of the observatory, made observations for 1842, 1843 and 1844, but those for 1843 and 1844 only are available to me, and Professor Orlebar has published observations from April to December 1845. In addition to the above, a meteorological register is kept in the office of the Deputy Surveyor-General in Calcutta, the instruments since 1844 being new, and of Newman's construction; but hourly observations do not appear to have been taken, and three out of the five periods of observation, namely, sunrise, noon and sunset, are useless for determining the diurnal oscillation of the barometer; and the barometrical observations taken before the receipt of the new instruments, which came to hand respectively in 1844 and 1847, were recorded from defective instruments.

Troughton's barometer reduced to 32° stood at . . .	29·493
Colonel Everest's reduced to 32° stood at	29·637
While Newman's barometer of Sept. 1844 stood at . . .	29·654
And that of April 1847 at	29·667

The height of the cistern above the level of the sea being 18·21 feet. Observations are also taken at the Royal Observatory at Oude, and at the Rajah of Travancore's Observatory at Trevandrum; but the records have not reached my hands, nor are those of the magnetic observatory at Simla available to me.

Independently of the diurnal atmospheric tides, the Dodabetta observations afford the means of further investigating the debatable question of the influence of elevation upon the quantity of rain precipitated; for these observations, contrasted with the records from Mahabuleshwur, Mercara in Coorg, and from the numerous stations in Travancore furnished by General Cullen (all the localities being under nearly the same meridian, although differing greatly in latitude), will supply data, which, if they do not set the question at rest, will assist to guide the judgement to deductions approximating to the truth.

Diurnal Tides.—I shall first notice the observations taken at the greatest elevation. The Dodabetta observations commenced in February 1847. The locality of the observatory, which is in latitude 11° 23′ 22″ N., and longitude approximatively 76°·47 E. of Greenwich, is understood to be the highest point in the range of Ghauts in Western

* At Madras, from the years 1822 to 1837, the barometric records are useless for determining the daily atmospheric tides, the hours of observation being sunrise,—10 A.M., noon,—2 P.M., and sunset,—10 P.M. was added in some of the latter years. Hourly observations only commenced in 1841.

India, that run parallel to the sea-coast from latitude 24°—25° to Cape Comorin. This range of mountains rise abruptly above the western coast of India, and the watershed from them is almost entirely to the Coromandel or eastern coast of the Peninsula of India. The aqueous vapours from the ocean are condensed on these mountains, and as Dodabetta is within the influence of both the south-west and north-east monsoons, it would appear to be favoured with rain in every month in the year. The observations were taken by an assistant of the Madras Observatory, JOHN DE CRUZ; and as the instruments had been selected by the astronomer, Mr. TAYLOR, and every precaution taken to ensure accuracy in the observations, there is every reason to suppose they are worthy of confidence. To determine the pressure of the atmosphere, observations were taken only twice in the day at the supposed hours of maxima and minima; namely, $9^{h}\ 40^{m}$ A.M. and $3^{h}\ 40^{m}$ P.M., excepting on the 21st and 22nd of each month, when the observations were taken hourly for twenty-four consecutive hours.

With respect to the daily oscillation of the barometer the following Tables are given, and the records show, that, as in my observations in the Deccan, there is not at this great elevation *a single day throughout the whole year* in which the pressure at $3^{h}\ 40^{s}$ P.M. is higher than at $9^{h}\ 40^{s}$ A.M., and there is but a solitary instance in which the pressure at the two hours is identical. On the 15th of August the barometer is recorded as standing at 21°·952 at $9^{h}\ 40^{m}$ A.M., and at 21°·952 at $3^{h}\ 40^{m}$ P.M.; but as there is not an approximation to anything similar in the preceding or following days, it may be questioned whether this supposed suspension of the atmospheric tide may not be a typographical error, that might well be excused in a multitude of figures. As these observations taken at such a height are the first of the kind recorded in India, I have thought it right to append them *in extenso*; at least for pressure and temperature, and wet bulb depression*.

* While this paper is passing through the press, Lieut. R. STRACHEY of the Bengal Engineers is arrived in England from his travels in the Himalayas and Thibet. He made some hourly observations of the barometer at an elevation of 18,400, at 16,000, and at 11,500 feet, and found that the horary oscillations or atmospheric tides were as regular as on the plains of Hindoostan, and the hours of maxima and minima were the same.

Meteorological observations made by Lieut. R. STRACHEY on Lunjar Mountain in Thibet (lat. 31° 2′ north) at an elevation of 18,400 feet above the sea, August 22nd and 23rd, 1849.

Date.	Hour.	Bar. at 32°.	Air.	Wet bulb.		Date.	Hour.	Bar. at 32°.	Air.	Wet. bulb.	
	P.M. h m	in.					P.M. h m	in.			
Aug. 22.	2 0	15·374	45·0	37·7	Moderate wind and a few light clouds.	Aug. 23.	4 0	15·381	29·0	24·3	Calm, clear.
	4 30	·355	48·7	37·8	Moderate wind and a few light clouds.		5 0	·389	29·0	24·5	Calm, clear.
	5 0	·355	42·7	36·2	Moderate wind and a few light clouds.		6 0	·393	28·0	26·5	Sunrise.
	6 0	·362	37·7	35·5	Moderate wind and a few light clouds.		7 0	·397	33·0	32·8	Calm and clear.
	7 0	·369	31·5	29·9	Wind light.		8 0	·405	36·0	35·8	Calm and clear.
	8 0	·396	34·0	29·5	Wind light.		9 0	·420	39·8	31·75	Calm and clear.
	9 0	·410	33·6	28·9	Calm, clear.		10 0	·424	44·9	35·5	Light winds, S.E., few clouds.
	10 0	·412	33·0	28·5	Calm, clear.		11 0	·421	56·2	46·5	Wind increasing, also clouds.
	11 0	·414	32·0	26·7	Calm, clear.		noon.	·415	56·0	40·2	
	midnight.	·394	31·7	27·7	Calm, clear.		1 0	·407	56·9	40·9	
Aug. 23.	1 15	·399	31·0	25·25	Calm, clear.		1 30	·404			
	2 0	·395	30·7	27·4	Calm, clear.		2 0	·397	49·1	37·15	
	3 0	·383	29·7	27·6	Calm, clear.		3 0	·387	46·5	36·5	Strong wind and more cloudy.

Daily Oscillations of the Barometer at Dodabetta, at 8640 feet above the level of the sea, &c.

FEBRUARY.

Date. 1847.	h m 9 40 A.M. Barometer.	Att.	Det.	h m 3 40 P.M. Barometer.	Att.	Det.	Rain.
	in.	°	°	in.	°	°	in.
1	22·105	52·5	54·0	22·046	51·0	52·0	—
2	·115	53·0	54·0	·062	50·0	52·0	—
3	·114	53·0	53·8	·068	53·0	52·9	0·02
4	·124	51·8	52·5	·060	53·0	52·8	0·31
5	·128	50·0	51·0	·072	52·9	52·5	0·03
6	·140	48·8	50·0	·086	52·2	50·0	0·02
7	·136	47·8	48·0	·085	51·0	51·0	—
8	·138	51·4	53·0	·082	52·0	52·5	—
9	·144	51·5	52·5	·064	52·5	52·5	0·38
10	·082	51·4	48·0	·022	50·0	50·5	0·03
11	·082	50·0	51·0	·014	51·0	51·4	0·05
12	·120	52·2	53·0	·056	50·5	52·2	0·05
13	·154	52·4	53·0	·081	52·4	53·0	1·39
14	·134	51·8	52·0	·068	52·0	53·0	0·39
15	·142	53·0	54·0	·073	53·0	53·4	0·69
16	·138	54·4	55·0	·072	54·5	54·5	3·24
17	·140	53·5	55·0	·089	54·5	54·5	—
18	·165	52·0	54·0	·099	53·0	53·5	—
19	·158	52·0	52·5	·066	52·5	53·0	—
20	·132	50·5	51·0	·046	53·0	53·0	0·03
21	·123	51·8	51·8	·068	53·8	53·0	0·03
22	·139	49·8	50·5	·079	51·8	52·0	0·77
23	·132	50·5	51·0	·080	51·3	52·0	—
24	·128	51·0	52·0	·066	52·5	53·0	—
25	·134	51·8	54·0	·076	52·0	53·0	—
26	·116	51·0	52·0	·080	52·0	52·0	—
27	·110	50·0	51·0	·062	51·0	52·4	—
28	·128	48·5	49·5	·084	50·0	51·0	—
Mean	22·129	51·3	52·1	22·068	52·1	52·5	7·43

MARCH.

Date. 1847.	h m 9 40 A.M. Barometer.	Att.	Det.	h m 3 40 P.M. Barometer.	Att.	Det.	Rain.
	in.	°	°	in.	°	°	in.
1	22·166	52·0	53·0	22·072	51·0	52·0	—
2	·182	54·0	54·0	·130	52·0	53·0	—
3	·186	53·0	53·4	·122	52·8	53·0	2·29
4	·168	50·0	50·5	·116	50·0	51·0	0·03
5	·180	50·4	50·8	·124	50·5	51·5	—
6	·174	50·0	53·0	·126	50·8	51·8	—
7	·166	50·0	52·0	·130	50·0	51·0	—
8	·182	52·2	53·0	·130	54·0	54·0	—
9	·159	50·0	51·8	·098	53·0	53·0	—
10	·172	54·0	55·0	·100	56·8	57·0	—
11	·153	55·0	56·0	·078	53·0	54·0	—
12	·148	55·0	56·0	·106	53·0	55·0	—
13	·158	55·0	56·0	·105	55·0	55·0	—
14	·152	52·0	53·0	·118	58·8	59·0	—
15	·150	51·8	53·0	·088	53·0	53·5	0·77
16	·176	51·0	52·0	·147	53·0	53·0	0·16
17	·218	21·0	51·5	·128	52·0	52·0	0·21
18	·186	54·2	55·2	·084	53·0	53·0	0·25
19	·136	52·0	53·0	·066	54·0	54·0	—
20	·160	53·0	54·0	·123	55·0	55·0	—
21	·186	53·0	54·8	·150	55·0	56·0	—
22	·168	51·0	50·0	·104	55·0	56·0	—
23	·140	56·0	57·0	·116	56·0	56·5	—
24	·131	58·0	58·0	·076	55·0	56·8	—
25	·146	57·0	55·0	·086	58·5	58·0	—
26	·132	57·0	58·0	·089	57·0	57·5	—
27	·138	56·0	57·0	·064	56·0	57·5	—
28	·140	56·0	57·0	·072	56·0	57·0	—
29	·136	56·0	57·0	·080	56·0	57·0	—
30	·184	57·0	58·0	·120	57·5	58·8	—
31	·190	57·0	59·0	·117	57·5	58·0	—
Mean	22·160	53·5	54·4	22·105	54·2	54·6	3·61

APRIL.

Date. 1847.	h m 9 40 A.M. Barometer.	Att.	Det.	h m 3 40 P.M. Barometer.	Att.	Det.	Rain.
	in.	°	°	in.	°	°	in.
1	22·180	58·0	59·0	22·106	58·0	58·5	—
2	·177	59·5	61·5	·080	58·5	60·0	—
3	·172	59·0	60·5	·115	58·0	59·0	—
4	·186	58·0	59·0	—	—	—	—
5	·199	57·5	58·5	·164	58·0	58·0	—
6	·188	56·0	57·0	·150	60·0	59·0	—
7	·172	56·0	57·5	·119	57·0	57·4	—
8	·160	57·0	58·5	·110	58·5	58·5	0·05
9	·162	54·8	56·0	·106	57·0	58·0	0·06
10	·176	56·0	57·0	·110	56·5	57·5	—
11	·136	56·5	57·0	·114	56·0	57·0	—
12	·122	56·5	57·5	·058	57·0	58·0	—
13	·098	55·0	56·0	·038	56·0	56·0	1·77
14	·100	53·8	54·0	·026	55·0	55·0	0·02
15	·036	52·5	53·5	21·983	51·8	51·5	0·10
16	21·998	51·0	51·8	·912	51·0	51·5	1·14
17	·946	53·5	54·0	·886	53·0	53·0	4·75
18	22·016	53·0	53·0	·952	53·5	53·5	10·00
19	·056	53·0	53·0	22·012	53·0	53·5	1·72
20	·088	52·0	53·0	·056	54·0	54·0	0·09
21	·126	52·0	52·0	·078	57·0	57·0	—
22	·128	52·8	53·0	·072	54·0	55·0	—
23	·128	54·5	54·0	·060	57·0	58·0	—
24	·128	54·8	55·5	·070	55·0	56·5	—
25	·142	58·0	58·0	·074	55·0	56·0	—
26	·170	56·5	57·0	·100	57·0	58·0	—
27	·164	57·0	58·0	·090	58·0	59·0	—
28	·172	58·0	59·0	·093	57·0	56·5	—
29	·160	55·8	56·5	·078	56·5	57·0	0·05
30	·160	58·0	58·0	·088	58·0	58·5	0·05
Mean	22·128	55·5	56·3	22·066	56·1	56·6	19·80

Depression of the wet bulb.

Date.	February. h m 9 40 A.M.	February. h m 3 40 P.M.	March. h m 9 40 A.M.	March. h m 3 40 P.M.	April. h m 9 40 A.M.	April. h m 3 40 P.M.
1	10·5	1·5	6·0	0·0	5·0	2·0
2	2·0	5·0	3·0	1·0	7·5	2·5
3	1·8	1·5	0·9	1·0	4·5	1·2
4	0·5	0·8	4·5	2·0	7·0	—
5	2·0	1·1	4·3	2·1	5·0	4·0
6	3·5	2·2	6·0	3·3	7·0	7·0
7	6·5	2·5	4·0	2·0	6·5	2·9
8	1·8	1·5	6·0	3·5	4·5	5·2
9	0·5	1·5	3·8	1·0	6·5	5·2
10	1·5	0·5	7·0	5·0	5·5	2·5
11	0·2	0·4	9·0	2·0	6·2	6·0
12	0·5	0·2	8·8	2·0	2·5	3·0
13	0·0	0·4	7·2	6·0	1·0	1·0
14	0·0	0·5	4·5	4·5	0·5	0·5
15	0·4	0·4	1·0	1·5	1·0	0·5
16	0·5	0·5	0·8	0·5	0·5	0·5
17	2·0	1·5	0·5	1·0	1·5	0·0
18	4·0	0·9	2·2	2·0	0·3	0·5
19	0·7	0·5	2·2	4·2	0·0	0·5
20	0·6	0·5	6·2	4·0	0·5	0·0
21	1·3	0·8	6·0	7·0	1·0	4·5
22	0·5	0·5	10·0	10·0	7·0	3·0
23	0·0	0·0	8·0	9·5	5·0	3·2
24	0·5	0·6	7·0	4·8	1·5	1·0
25	4·0	1·0	5·0	6·0	5·0	2·0
26	3·0	1·5	6·0	5·0	3·0	3·5
27	2·0	2·4	7·2	7·7	3·0	2·5
28	2·0	1·2	4·0	2·0	4·0	1·5
29			6·0	2·5	1·5	3·0
30			3·2	1·8	5·0	2·5
31			4·8	2·0		
Mean	1·9	1·1	5·0	3·5	3·6	2·5

TABLE (Continued).

MAY.

Date. 1847.	9h 40m A.M. Barometer.	9h 40m A.M. Att.	9h 40m A.M. Det.	3h 40m P.M. Barometer.	3h 40m P.M. Att.	3h 40m P.M. Det.	Rain.
	in.	°	°	in.	°	°	in.
1	22·150	58·5	59·0	22·072	57·0	56·5	—
2	·124	56·5	57·0	·062	57·4	58·0	—
3	·140	58·0	59·0	·084	59·0	59·0	—
4	·135	57·5	58·8	·080	57·5	58·0	0·01
5	·138	57·2	58·0	·052	56·0	55·4	—
6	·154	57·0	58·0	·078	57·0	57·0	1·26
7	·154	57·5	58·0	·093	57·2	58·0	—
8	·169	56·5	57·5	·096	58·5	59·0	0·06
9	·140	57·5	58·5	·082	58·2	58·0	—
10	·142	58·0	58·0	·048	58·0	58·0	—
11	·118	58·5	59·4	·074	57·4	58·0	—
12	·114	58·0	59·0	·052	58·4	59·0	—
13	·138	57·4	58·4	·082	57·0	58·4	0·64
14	·112	57·5	58·0	·062	57·0	57·4	—
15	·126	57·8	58·2	·052	57·5	57·9	—
16	·102	58·0	58·4	·030	58·8	59·2	0·05
17	·090	58·0	58·5	·040	57·2	58·0	0·30
18	·096	57·0	57·0	·044	57·5	58·0	0·02
19	·102	59·4	60·0	·024	58·8	58·5	0·12
20	·046	55·0	55·0	21·972	56·2	56·8	1·05
21	·012	57·8	58·0	·948	58·0	57·5	0·03
22	·018	58·9	58·5	·982	58·0	57·6	0·02
23	·040	56·5	56·9	·942	58·2	57·8	0·07
24	·020	55·2	55·8	·930	57·0	56·8	0·08
25	·006	54·0	54·5	·952	56·2	56·0	0·31
26	·026	54·5	55·0	·974	55·8	56·2	0·09
27	·036	55·4	55·6	·962	57·4	57·0	0·12
28	21·986	53·8	54·0	·943	53·5	53·8	0·04
29	·990	52·0	52·5	·946	53·6	53·8	0·25
30	22·030	52·5	52·0	—	—	—	0·16
31	·054	54·5	54·8	·960	53·5	53·2	0·18
Mean	22·087	56·6	57·1	22·024	57·1	57·3	4·86

JUNE.

Date. 1847.	9h 40m A.M. Barometer.	9h 40m A.M. Att.	9h 40m A.M. Det.	3h 40m P.M. Barometer.	3h 40m P.M. Att.	3h 40m P.M. Det.	Rain.
	in.	°	°	in.	°	°	°
1	22·016	52·8	53·0	21·964	53·5	52·8	—
2	·038	51·2	51·5	22·002	52·8	52·0	0·10
3	·042	51·4	52·0	·016	52·5	52·0	—
4	·069	52·8	53·0	·009	53·8	54·0	0·02
5	·062	54·8	55·0	21·978	52·0	52·2	0·40
6	·026	52·5	52·5	·999	55·5	55·5	0·19
7	·068	52·4	52·6	22·008	53·2	53·8	—
8	·067	52·0	52·2	·008	53·6	53·9	0·04
9	·056	53·2	53·6	21·974	52·4	52·8	0·03
10	21·984	50·5	50·8	·968	52·5	53·0	—
11	·982	51·6	51·9	·918	51·5	51·8	0·13
12	·940	49·8	50·0	·884	50·2	50·3	0·08
13	·963	50·8	51·4	·930	53·8	54·2	0·56
14	22·004	51·8	52·2	·956	53·4	53·8	—
15	·063	52·8	53·2	·961	51·2	51·6	0·05
16	·068	50·5	50·9	·924	51·3	51·5	0·04
17	21·964	49·5	50·0	·924	51·8	51·8	—
18	·986	55·0	55·5	·940	55·6	56·0	—
19	·996	52·2	52·8	·940	52·3	52·8	0·43
20	·996	52·4	52·9	·958	52·8	53·0	0·03
21	·960	52·8	52·9	—	—	—	0·25
22	·916	52·2	52·4	·858	52·4	52·6	—
23	·848	52·0	52·0	·800	50·0	50·0	0·09
24	·924	51·4	51·5	·880	51·8	51·8	1·00
25	·956	51·7	51·7	·912	52·0	52·2	0·07
26	22·006	51·6	51·8	·954	52·5	52·2	0·21
27	21·952	49·2	49·2	·926	50·8	51·0	0·07
28	·946	51·0	51·0	·880	51·8	52·0	0·33
29	·912	51·0	51·2	·879	50·0	50·4	0·08
30	·964	51·0	51·0	·920	52·0	52·4	0·35
Mean	21·992	51·8	52·1	21·940	52·4	52·9	4·55

JULY.

Date. 1847.	9h 40m A.M. Barometer.	9h 40m A.M. Att.	9h 40m A.M. Det.	3h 40m P.M. Barometer.	3h 40m P.M. Att.	3h 40m P.M. Det.	Rain.
	in.	°	°	in.	°	°	in.
1	22·026	51·2	51·2	21·942	52·0	52·0	0·45
2	·005	51·2	51·6	·946	52·8	53·1	0·13
3	21·976	51·6	51·9	·930	52·6	53·0	0·15
4	22·010	51·9	52·2	·965	53·0	53·2	0·35
5	·016	51·8	51·9	·946	51·0	51·0	0·29
6	·029	51·8	52·2	·984	52·9	52·9	0·21
7	·024	52·4	52·6	·990	51·0	50·8	0·12
8	·030	52·8	52·9	·968	53·0	53·0	0·16
9	·022	51·0	51·2	·960	52·0	52·4	0·02
10	21·990	51·0	51·4	·932	51·6	51·5	0·08
11	·972	48·8	49·0	·946	53·2	53·5	0·02
12	22·020	51·5	51·8	·980	54·2	54·5	0·04
13	·032	52·0	52·2	·958	52·8	53·2	0·24
14	21·992	51·8	52·0	·942	52·4	52·5	0·52
15	·990	52·0	52·2	·934	53·6	53·8	0·17
16	·992	52·2	52·5	·957	52·5	53·0	—
17	22·010	51·8	52·0	·970	53·2	53·4	0·08
18	·016	51·0	51·0	·972	53·4	53·9	0·03
19	·012	52·0	52·8	·956	52·0	52·4	0·05
20	·004	53·8	53·9	·955	52·4	52·8	0·02
21	·024	53·9	53·9	·962	54·4	54·5	0·21
22	21·998	54·0	54·0	·931	55·5	55·5	0·16
23	·992	53·2	53·5	·924	54·3	54·6	0·03
24	·984	53·0	53·8	·925	53·0	53·2	1·15
25	·956	51·0	51·2	·948	52·5	52·8	0·18
26	·958	51·9	52·2	·889	52·0	52·2	0·55
27	·939	51·5	51·8	·915	52·2	52·5	0·70
28	·950	52·8	53·0	·913	52·2	52·5	0·63
29	·974	52·8	53·1	·961	52·0	52·1	0·38
30	22·032	52·5	52·8	·962	53·2	53·6	0·24
31	·030	53·1	53·4	·964	53·0	53·1	0·05
Mean	22·000	52·0	52·3	·949	52·8	53·0	7·41

Depression of the wet bulb.

Date. 1847.	May. 9h 40m A.M.	May. 3h 40m P.M.	June. 9h 40m A.M.	June. 3h 40m P.M.	July. 9h 40m A.M.	July. 3h 40m P.M.
	°	°	°	°	°	°
1	3·0	2·1	0·2	0·3	0·0	0·2
2	3·0	2·0	2·0	0·6	0·1	0·6
3	5·0	3·0	1·0	1·0	0·1	0·6
4	5·4	4·0	1·6	0·2	0·2	0·2
5	3·0	4·5	0·5	0·4	0·3	0·5
6	2·5	1·0	0·0	0·7	0·2	0·3
7	2·0	1·8	0·8	0·4	0·8	0·4
8	2·5	3·0	0·4	0·7	0·1	0·0
9	4·5	1·5	1·4	0·4	1·4	0·4
10	2·0	3·0	3·6	1·0	1·2	0·5
11	4·9	3·0	0·4	0·6	3·0	0·7
12	3·0	2·9	0·5	0·3	0·9	1·0
13	3·0	2·9	0·6	1·2	0·2	0·2
14	3·0	2·2	4·0	0·3	0·0	0·1
15	3·2	1·4	1·0	0·2	0·2	0·6
16	5·4	3·2	3·5	0·3	0·3	0·6
17	3·3	3·5	2·1	0·3	0·2	0·4
18	5·2	3·0	1·7	0·5	0·0	0·7
19	5·0	3·3	0·8	0·6	1·0	0·4
20	1·1	0·8	0·9	0·2	0·7	0·6
21	1·5	1·0	0·1	—	0·1	0·5
22	1·5	1·1	0·5	0·6	0·1	0·3
23	0·9	1·0	0·2	0·5	0·3	0·4
24	0·3	0·8	0·1	0·4	0·8	0·3
25	0·5	0·5	0·1	0·2	0·2	0·4
26	0·5	0·2	0·3	0·2	0·2	0·2
27	0·4	1·1	0·4	0·2	0·4	0·4
28	0·2	0·4	0·0	0·4	0·2	0·3
29	0·5	0·5	0·3	0·2	0·1	0·1
30	0·0	—	0·0	0·2	0·6	0·8
31	0·0	0·2	......	......	0·3	0·3
Mean	2·5	2·0	1·0	0·4	0·5	0·4

TABLE (Continued).

AUGUST. Date. 1847.	h m 9 40 A.M. Baro-meter.	Att.	Det.	h m 3 40 A.M. Baro-meter.	Att.	Det.	Rain.
	in.	°	°	in.	°	°	in.
1	22·012	52·1	52·2	21·934	52·4	52·9	0·46
2	21·972	52·8	53·0	·912	52·2	52·2	0·25
3	·979	52·0	52·2	·937	52·0	52·1	0·21
4	·971	51·0	51·2	·920	52·5	52·8	0·12
5	·979	51·9	52·0	·920	52·1	52·2	0·59
6	·978	51·8	51·9	·910	52·4	52·5	0·79
7	·974	52·4	52·5	·892	51·4	51·5	0·74
8	·972	52·0	52·2	·932	53·0	53·2	0·03
9	22·034	53·4	53·5	·974	53·1	53·1	0·50
10	·072	53·2	53·4	22·026	54·0	54·2	0·37
11	·090	53·2	53·5	·032	53·0	53·0	0·18
12	·070	52·0	52·2	·009	53·0	53·2	0·73
13	·052	52·2	52·5	21·988	52·1	52·1	0·08
14	21·973	50·2	50·3	·932	50·6	50·9	0·18
15	·952	52·0	52·2	·952	51·1	51·2	—
16	22·022	51·4	51·8	·984	51·5	51·8	0·25
17	·046	53·3	53·4	·993	54·5	54·9	0·25
18	·057	53·9	53·2	22·017	55·1	55·5	0·20
19	·066	52·5	52·8	·018	54·0	54·2	—
20	·071	55·4	56·0	·022	53·8	54·2	0·02
21	·090	53·5	54·0	·022	55·0	55·2	—
22	·084	54·9	55·0	·022	55·1	55·3	0·18
23	·055	53·2	53·3	·006	54·3	54·5	1·63
24	·048	54·5	54·8	·014	53·0	53·5	—
25	·078	53·1	53·4	·010	53·6	54·0	0·50
26	·060	52·2	52·5	21·986	55·0	55·2	0·30
27	·032	52·0	52·0	·998	53·5	53·5	0·23
28	·059	54·8	55·1	·990	53·1	53·1	0·06
29	·040	52·2	52·5	·980	51·9	52·0	0·29
30	·019	53·0	53·1	·960	53·5	53·8	0·03
31	·028	53·0	53·0	·955	53·0	53·0	0·15
Mean.	22·030	52·8	52·9	21·976	53·1	53·3	9·32

SEPTEMBER. Date. 1847.	h m 9 40 A.M. Baro-meter.	Att.	Det.	h m 3 40 P.M. Baro-meter.	Att.	Det.	Rain.
	in.	°	°	in.	°	°	in.
1	22·032	53·5	53·8	21·976	53·0	53·0	0·36
2	·050	53·1	53·2	22·010	53·5	53·5	0·55
3	·052	53·5	53·4	21·990	53·0	53·0	0·17
4	·030	51·8	52·0	·980	53·0	53·0	0·35
5	·030	50·1	50·2	·967	51·8	51·8	0·36
6	21·928	48·5	48·6	·913	50·1	50·2	0·15
7	·948	51·5	51·8	·900	50·2	50·4	0·48
8	·932	50·4	50·5	·876	51·5	51·6	0·50
9	·880	50·8	50·8	·879	51·9	52·0	0·32
10	·976	51·8	51·9	·934	52·2	52·5	0·34
11	·967	51·2	51·5	·900	52·0	52·2	0·40
12	·984	51·3	51·5	—	—	—	0·28
13	22·006	51·6	52·2	·978	51·9	52·0	0·20
14	·024	52·2	52·4	22·010	51·9	52·1	0·15
15	·050	53·1	53·3	21·990	52·0	52·2	0·12
16	·066	52·3	53·5	22·012	54·4	54·5	0·07
17	·070	52·6	53·0	·002	53·8	54·1	0·08
18	·078	49·5	49·8	·019	53·8	54·1	—
19	·074	52·6	53·1	·012	52·8	53·2	—
20	·088	52·0	52·4	·020	53·2	53·5	0·37
21	·066	53·6	54·0	21·988	54·5	54·7	0·78
22	·071	53·2	53·5	22·006	54·0	54·3	0·66
23	·100	53·4	54·0	·034	53·8	54·0	—
24	·088	47·2	48·0	·022	52·5	54·0	—
25	·079	49·8	51·0	·020	52·5	53·0	—
26	·082	51·5	52·2	·020	53·5	54·4	—
27	·064	52·5	53·1	21·984	52·9	53·1	0·03
28	·047	52·3	52·5	·986	52·5	53·0	0·55
29	·029	49·6	50·1	·963	52·6	53·1	0·18
30	·028	51·4	52·0	·946	52·5	52·6	0·07
Mean.	22·031	51·6	52·0	21·977	52·7	52·9	7·52

OCTOBER. Date. 1847.	h m 9 40 A.M. Baro-meter.	Att.	Det.	h m 3 40 P.M. Baro-meter.	Att.	Det.	Rain.
	in.	°	°	in.	°	°	in.
1	22·000	51·0	51·5	21·960	52·1	52·5	
2	·046	52·5	53·0	22·013	52·1	52·2	0·02
3	·086	52·8	53·1	·032	52·5	53·0	
4	·122	53·5	53·8	·058	55·0	55·2	0·02
5	·100	53·4	54·0	·028	53·4	53·6	0·36
6	·084	51·6	52·0	·012	52·3	52·5	0·44
7	·104	52·0	52·5	·026	53·0	53·0	0·02
8	·124	52·5	53·1	·040	53 2	53·5	0·14
9	·116	52·6	53·0	·028	52·8	53·1	0·05
10	·090	53·9	54·3	·002	53·2	53·4	0·45
11	·072	53·4	53·5	21·994	55·1	55·2	1·21
12	·098	53·8	54·1	22·030	54·2	54·4	0·67
13	·076	53·0	53·2	21·989	53·0	53·0	0·11
14	21·999	51·9	52·1	·900	51·4	51·6	1·82
15	22·016	53·1	53·4	·958	53·8	54·0	0·92
16	·052	53·5	53·8	·990	53·9	54·1	0·17
17	·088	53·4	53·5	22·022	54·4	54·8	0·09
18	·110	53·5	53·5	·032	55·1	55·3	0·11
19	·089	54·2	54·4	·010	54·3	54·5	0·30
20	·122	53·4	54·0	·031	53·5	53·8	1·24
21	·129	54·4	54·9	·035	53·0	53·3	0·54
22	·116	54·0	54·5	·034	54·8	55·2	0·29
23	·104	52·2	52·5	·048	53·8	53·8	2·39
24	·111	52·2	52·5	·047	52·4	52·5	0·07
25	·092	52·4	52·8	·026	53·2	53·5	0·19
26	·116	53·9	54·2	·034	53·9	54·0	0·01
27	·092	55·2	55·3	·036	54·2	54·5	0·04
28	·102	51·6	52·2	·020	51·5	51·5	
29	·077	49·4	50·2	·014	50·5	50·5	0·06
30	·056	51·4	51·6	21·991	52·0	52·0	0·10
31	·064	52·2	52·5	·998	53·0	53·2	0·66
Mean.	22·086	52·8	53·2	22·014	53·2	53·4	12·49

Date.	Depression of the wet bulb. August. h m 9 40 A.M.	August. a m 3 40 P.M.	September. h m 9 40 A.M.	September. h m 3 40 P.M.	October. h m 9 40 A.M.	October. h m 3 40 P.M.
1	0·1	0·5	0·3	0·1	6·0	2·5
2	0·1	0·1	0·0	0·1	0·7	0·2
3	0·3	0·2	0·0	0·0	0·1	1·0
4	0·2	0·8	0·2	0·1	0·3	0·2
5	0·0	0·1	0·1	1·2	1·0	0·3
6	0·1	0·5	1·6	0·1	0·8	0·5
7	0·1	0·0	0·3	0·2	0·4	0·5
8	0·2	0·2	0·1	0·3	0·7	0·3
9	0·5	0·1	0·3	0·2	0·5	0·3
10	0·4	0·2	0·4	0·4	0·4	0·2
11	0·3	0·0	0·3	0·2	0·1	0·1
12	0·9	0·2	0·2	—	0·1	0·3
13	0·3	0·3	0·4	0·5	0·1	0·0
14	0·2	0·3	0·2	0·2	0·1	0·2
15	0·2	0·8	0·2	0·2	0·2	0·1
16	0·4	2·6	0·3	0·2	0·2	0·1
17	0·1	0·5	0·6	0·3	0·0	0·4
18	0·2	0·3	2·6	0·6	0·1	0·2
19	3·0	0·4	0·6	0·5	0·2	0·3
20	9·6	0·5	0·4	0·6	0·5	0·2
21	0·5	0·2	0·5	0·2	0·4	0·3
22	0·4	0·3	1·0	0·4	0·5	0·8
23	0·8	0·4	0·9	0·2	0·2	0·3
24	1·8	0·5	3·5	7·0	0·2	0·1
25	0·9	0·4	5·8	1·1	0·3	0·1
26	2·0	0·6	0·8	0·6	0·3	0·1
27	0·0	0·3	0·7	0·1	0·1	0·3
28	2·1	0·6	0·6	0·6	1·4	0·6
29	0·3	0·1	0·6	0·8	1·4	1·3
30	0·1	1·4	1·0	1·1	0·2	0·0
31	0·0	0·0	...	...	0·3	0·4
Mean.	0·8	0·4	0·8	0·6	0·6	0·4

Table (Continued).

NOVEMBER.							
Date.	h m 9 40 A.M.			h m 3 40 A.M.			
1847.	Barometer.	Att.	Det.	Barometer.	Att.	Det.	Rain.
	in.	°	°	in.	°	°	in.
1	22·093	53·2	53·3	22·030	52·6	52·8	1·03
2	·083	51·8	52·1	·022	52·2	52·4	1·64
3	·014	52·2	52·5	21·982	52·6	52·9	1·10
4	·114	52·6	52·9	22·046	53·5	53·5	2·32
5	·140	53·0	53·3	·060	52·6	52·8	0·75
6	·113	52·0	52·8	·050	53·0	53·4	1·35
7	·060	52·2	52·6	21·966	51·0	51·2	0·24
8	·064	52·6	53·0	22·010	52·2	52·6	0·12
9	·080	49·0	49·5	·064	50·0	50·2	
10	·074	48·0	49·0	·035	50·2	50·5	0·03
11	·120	48·8	50·0	·056	51·5	51·5	0·06
12	·150	51·5	51·5	·080	51·8	52·2	
13	·152	51·2	51·5	—	—	—	0·04
14	·136	51·4	51·8	·064	51·5	52·0	0·17
15	·108	46·8	50·4	·052	48·9	49·2	0·04
16	·068	45·2	48·5	·006	47·0	47·2	
17	·058	47·5	49·5	·002	48·0	48·6	
18	·104	53·0	55·8	·034	51·8	52·5	
19	·130	52·2	53·1	·052	51·4	51·8	
20	·117	51·9	52·5	·046	51·5	51·5	0·24
21	·108	49·0	51·4	·059	51·6	51·5	0·18
22	·136	54·0	56·1	·064	53·0	53·9	
23	·116	52·2	53·0	·048	53·0	53·3	
24	·106	52·0	52·9	·035	53·1	53·5	0·19
25	·102	53·8	54·0	·030	53·4	53·5	0·85
26	·109	52·2	52·5	·032	53·9	54·0	0·11
27	·098	53·4	54·0	·034	53·1	53·4	0·20
28	·094	53·5	54 0	·048	52·8	52·0	0·73
29	·100	52·0	52·5	·052	52·5	52·5	0·34
30	·106	52·0	52·4	·034	52·2	52·4	0·12
Mean.	22·117	51·3	52·3	22·038	51·8	52·0	11·85

DECEMBER.							
Date.	h m 9 40 A.M.			h m 3 40 P.M.			
1847.	Barometer.	Att.	Det.	Barometer.	Att.	Det.	Rain.
	in.	°	°	in.	°	°	in.
1	22·040	53·0	54·2	21·990	47·8	47·8	0·24
2	·036	51·5	52·1	·962	50·0	50·1	—
3	·032	51·5	51·8	·972	51·3	51·5	0·52
4	·056	53·2	54·0	22·006	51·0	52·0	0·53
5	·108	52·2	52·8	·056	52·3	52·5	5·15
6	·099	52·2	52·6	·038	52·8	52·8	0·40
7	·100	48·6	50·2	·026	50·5	51·2	0·15
8	·114	49·4	50·2	·048	50·2	50·4	0·02
9	·081	48·8	51·0	·010	49·2	49·5	—
10	·016	46·2	49·4	21·960	46·5	47·8	—
11	·004	46·8	48·5	·942	49·0	49·4	—
12	21·990	49·0	50·9	·926	50·0	50·2	—
13	·979	50·0	50·5	·921	50·0	50·4	0·89
14	·973	50·1	50·3	·928	50·2	50·3	0·96
15	22·020	46·2	47·5	·970	49·0	49·8	0·54
16	·056	47·2	47·8	22·004	51·2	51·8	—
17	·065	49·9	50·6	·014	50·4	51·0	0·07
18	·089	51·8	52·0	·022	52·0	52·4	0·30
19	·112	53·0	53·5	·033	51·9	52·4	1·29
20	·120	51·5	52·0	·050	52·4	52·5	0·60
21	·120	51·8	52·5	·036	52·0	52·1	—
22	·110	51·6	52·1	·044	52·5	52·5	0·05
23	·099	48·0	51·9	·040	49·4	49·0	—
24	·081	50·0	51·2	·046	48·5	48·2	—
25	·090	47·4	51·5	·032	51·0	50·2	—
26	·096	48·9	51·6	·044	51·1	51·0	—
27	·100	49·8	50·4	·042	50·0	50·5	—
28	·100	50·8	51·0	·050	49·1	49·4	0·36
29	·150	48·4	50·0	·081	49·0	49·0	0·21
30	·105	48·0	49·4	·039	49·0	49·1	—
31	·112	47·0	49·5	·064	48·8	49·0	—
Mean.	22·073	49·8	51·1	22·013	50·3	50·5	12·28

JANUARY.							
Date.	h m 9 40 A.M.			h m 3 40 P.M.			
1848.	Barometer.	Att.	Det.	Barometer.	Att.	Det.	Rain.
	in.	°	°	in.	°	°	in.
1	22·128	49·5	53·5	22·080	51·9	52·0	—
2	·138	47·0	49·4	·064	50·1	50·8	—
3	·125	49·0	49·4	·066	51·2	53·0	—
4	·132	51·6	52·5	·070	54·2	54·4	0 03
5	·128	51·4	52·5	·050	52·9	53·9	—
6	·112	52·0	53·2	·035	52·4	52·9	0·02
7	·092	51·1	52·4	·021	53·0	53·2	0·04
8	·080	49·6	50·4	·026	52·0	52·0	0·03
9	·102	47·3	50·0	·040	52·3	52·3	—
10	·092	49·2	50·6	·037	52·0	52·8	—
11	·120	52·5	54·2	·072	52·8	52·5	—
12	·130	52·8	55·3	·066	55·0	54·2	—
13	·099	51·5	57·0	·028	52·8	53·5	—
14	·090	52·0	54·5	·021	56·4	56·4	—
15	·074	48·6	50·0	·016	52·3	52·0	—
16	·101	51·8	52·9	·047	53·8	53·5	—
17	·132	53·5	56·5	·056	56·0	55·2	—
18	·119	50·8	51·0	·040	52·0	52·4	—
19	·100	50·3	51·1	·026	52·0	52·0	—
20	·108	49·0	49·6	·052	51·8	51·6	—
21	·101	49·2	50·0	·038	51·5	51·1	—
22	·120	52·8	54·0	·056	51·8	51·8	—
23	·112	49·2	51·0	·049	52·5	52·5	—
24	·090	49·0	52·1	·032	51·0	51·3	—
25	·102	49·0	51·8	·037	53·3	52·3	—
26	·100	48·8	51·0	·039	52·0	51·2	—
27	·120	49·0	50·8	·040	50·0	51·0	—
28	·134	49·8	51·5	·088	53·2	52·7	—
29	·163	47·5	50·0	·100	52·5	52·2	—
30	·132	49·5	50·2	·072	49·2	50·0	—
31	·124	49·5	51·2	·085	51·2	50·5	—
Mean.	22·113	50·1	51·9	22·050	52·4	52·5	0·12

Depression of the wet bulb.						
	November.		December.		January, 1848.	
Date.	h m 9 40 A.M.	h m 3 40 P.M.	h m 9 40 A.M.	h m 3 40 P.M.	h m 9 40 A.M.	h m 3 40 P.M.
	°	°	°	°	°	°
1	0·1	0·3	9·0	5·9	2·5	1·2
2	0·2	0·2	0·5	0·1	6·2	4·8
3	0·1	0·1	0·2	0·3	1·4	2·0
4	0·0	0·0	0·2	0·0	0·5	1·0
5	0·2	0·1	0·0	0·0	1·1	0·5
6	0·8	0·4	0·1	0·0	1·3	0·7
7	0·4	0·4	3·3	1·4	0·8	1·1
8	0·1	0·8	0·3	0·0	7·2	1·2
9	0·5	0·4	7·4	4·3	5·5	6·7
10	0·9	0·2	6·9	9·8	9·6	2·4
11	1·5	0·4	3·3	1·1	10·4	4·3
12	0·3	0·2	1·7	0·2	6·3	4·5
13	0·1	—	0·0	0·1	14·4	6·5
14	0·2	0·5	0·2	0·0	3·6	5·4
15	6·4	1·7	2·2	0·3	5·0	2·5
16	9·5	3·4	0·8	0·4	8·5	5·9
17	8·1	1·1	0·1	0·2	2·9	7·9
18	3·8	0·7	0·0	0·1	10·0	3·5
19	0·3	0·2	0·1	0·1	6·6	2·8
20	0·9	0·1	0·1	0·5	8·2	4·2
21	6·6	2·6	0·3	0·0	10·7	5·5
22	9·1	1·7	1·6	1·3	12·0	8·9
23	0·6	0·3	9·1	0·5	11·0	6·1
24	0·6	0·1	8·2	7·0	9·6	7·8
25	0·5	0·3	5·9	5·3	7·6	10·1
26	0·1	0·0	4·6	4·5	10·8	9·9
27	0·5	0·3	0·9	0·0	8·3	8·1
28	0·2	0·0	0·0	0·5	9·0	8·7
29	0·1	0·5	1·5	0·4	8·6	6·7
30	0·3	0·3	1·8	3·2	9·4	4·8
31			5·1	4·5	8·2	7·3
Mean.	1·8	0·6	2·4	1·7	7·0	4·9

On the 15th, 16th and 17th of November ice was found around the office at sunrise.

Range of Barometer at Dodabetta.

An inspection of the above Tables shows that the range of the daily pressure, on the whole, had been very regular. The minimum oscillation was 0·08 on the 25th of July, although on the preceding and following days it was respectively 0·059 and 0·069; on the 25th of July 0·18 of rain fell, but the oscillation was only 0·16 on the 10th of June, on which day no rain fell, and the wet bulb was depressed 3°·6 in the morning and 1° in the afternoon. There are two other instances in which the diurnal oscillation was less than three hundredths,—on the 11th of April ·022, and on the 3rd of June ·026. The maximum oscillation occurred on the 16th of June, and was ·144. The preceding day it was ·102, but the following day it was only ·040. On the 18th of March it was ·102, on the 1st of March ·094, and on the 19th of February ·092; with these few exceptions of maxima and minima in diurnal oscillation, the daily range of the barometer was from ·040 to ·060, showing no violent atmospheric changes. The maximum pressure was on the 17th of March, and was 22·218 in., and the minimum on the 23rd of June, when the barometer stood at 21·800, although only ·09 of an inch of rain fell on that day, and little for several days before. The extreme annual range of the barometer, therefore, was only ·418, or less than half an inch. I have shown, in my former paper in the Philosophical Transactions, that the annual range in the Deccan, at 1800 feet above the sea, was only ·672 in 1830, from 28·242 in. in January to 27·570 in July, the difference of the thermometer at the extreme periods being only 1°·4; and in no instance, on comparing the maximum pressure of one year with the minimum pressure of any other year, did the difference amount to eight-tenths of an inch. In GOLDINGHAM's tables at Madras, for twenty-one years, the greatest range in any year (with the single exception of a terrific storm in May 1820) appears to have been ·960 in 1818. In the more careful observations recorded by Capt. LUDLOW at the Madras Magnetic Observatory, from 1841 to 1845 both inclusive, *taken hourly*, the maximum range in 1842 (the observations for 1841 being imperfect) was from 30·156 at forty-one minutes past 9 A.M. on the 5th of December, to 29·454 on the 1st of June at 3^h 41^m P.M., and 29·455 on the 3rd of June at 4^h 41^m P.M., the range being 0·702 of an inch, the standard thermometer at the maximum pressure being 80°·6, and at the minimum 97°·3. In 1843 the maximum pressure was 30·208 on the 24th of January at 9^h 41^m A.M., and the minimum on the 21st of May being 29·256 at 3^h 41^m A.M., the range therefore 0·952; the thermometer at the maximum 81°·2, and at the minimum period 77° 8^m. In 1844 the maximum pressure was on the 16th of January, *i.e.* 30°·170 at 9^h 41^m A.M., and the minimum on the 1st of June, at 4^h 41^m P.M., *i. e.* 29·537, the range therefore 0·633, the thermometer at the first period being 79°·5, and at the second 89°·8. In 1845 the maximum pressure was on the 10th of January, 30°·196 at 9^h 41^m A.M., and the minimum on the 31st of May, 29°·531 at 4^h 41^m P.M., the range therefore 0·665: the thermometer at the maximum period was 79°·9, and at the minimum it was 101°·5. The following Table shows the extreme range of pressure at Madras, Bombay, Calcutta, &c.

Dates and Hours of the Maximum and Minimum Pressure at Madras, and extreme range of Barometer at Madras, Bombay, Calcutta, &c.

Years.	Max. Pres.	Date.	Hour.	Min. Pres.	Date.	Hour.	Annual range at Madras.	Annual range at Bombay.	Annual range at Calcutta.	Annual range at Poona.	Annual range at Maha-buleshwur.	Annual range at Dodabetta.
			h m			h m						
1842.	30·156	Dec. 5.	9 41 A.M.	29·454	June 1.	3 41 P.M.	0·702	......	......	*0·672		
1843.	30·208	Jan. 24.	9 41 A.M.	29·256	May 21.	3 41 P.M.	0·952	0·705				
1844.	30·170	Jan. 16.	9 41 A.M.	29·537	June 1.	4 41 P.M.	0·633	0·661	0·957			
1845.	30·196	Jan. 10.	9 41 A.M.	29·531	May 31.	4 41 P.M.	0·665	......	......			
1846.	......	......	......	......	......	......	0·723	......	0·869			
1847.	......	......	......	......	......	......	......	......	0·859	......		0·418
1848.	......	......	......	......	......	......	......	......	0·961	......	0·443†	

The maximum pressure, therefore, at Madras occurred at the *same hour* annually and within a range from the 5th of December to the 24th of January; and the minimum pressure occurred between 3^h 41^m and 4^h 41^m P.M., and within the range of ten days between the 21st of May and 1st of June. The maximum pressure at Dodàbetta, in 1847, was on the 17th of March, instead of December or January, as at Madras, but the minimum occurred in June, as at Madras. The Poona maximum was in January and the minimum in July; at Bombay, in 1843, the maximum pressure occurred on the same day and the same hour as at Madras, and the minimum pressure occurred equally in May, but on the 16th instead of the 21st of May. These facts Dr. BUIST recorded in a series of meteorological observations, taken hourly in Bombay for the year 1843, on the opposite side of the peninsula from Madras; and in his tables it is stated that the maximum pressure of the atmosphere, 30·136, occurred on the 24th of January at 10 A.M., and the minimum pressure, 29·431, on the 16th of May, before the monsoon set in, at 4 P.M.; the extreme range therefore being 0·705, while the extreme range at Madras in that year was 0·952, but the mean of the five years at Madras was 0·735. In Bombay, in 1844, the range was ·661 from 30·119 on the 13th of January to 29·458 on the 4th of June. At Calcutta unfortunately the observations were not taken hourly, and exact data are not attainable; but the record in 1846 states that the maximum pressure occurred on the 12th of January at 9^h 50^m A.M., viz. 30·225, and the minimum on the 25th of July at 4 P.M. 29·356, the annual range therefore 0·869. In 1847 the barometer stood highest on the 5th of February at 9^h 50^m, being 30·169, and the least pressure was on the 25th of May, at *sunset*, 29·310, the annual range therefore 0·859, singularly approximating to that of the preceding year, but in both years being greater than at Madras or Bombay. In 1848, at Calcutta, the maximum pressure was on the 24th of December 30·231 (9th of February 30·200, and 16th of February 30·191), and the minimum pressure on the 20th of July 29·270 (on 18th of June 29·353, and on 20th of May 29·459), the extreme range in the year

* For 1830. † For ten months of 1828–29.

therefore was 0·961. At no one of the places in the Table does there appear to have been a range of an inch; not only within the year, but taking the maximum pressure of one year with the minimum pressure of another year, the range of the barometer never amounted to 1 inch; and but for a record left by the late Mr. GOLDINGHAM, astronomer at Madras, it might be supposed the peninsula of India was not subject to any great changes of pressure. In a furious hurricane however which occurred at Madras on the 30th of October 1836, at 6 A.M., the barometer stood at 29·940, and at 7 P.M. it stood at 28·285, and stood at that during an awful lull until $7^h\ 45^m$ P.M., when the hurricane *recommenced* and the barometer *rose* to 28·725; the removal of pressure in thirteen hours amounting to 1·665 inch. But the area of any such removal of pressure would appear to be comparatively limited, and we are indebted to the elaborate researches of Mr. PIDDINGTON of Calcutta, and Colonel REID of the Royal Engineers, in their investigation of the Rotatory Storms or Cyclones within the tropics, for enabling us to give an approximative area to the great depressions of the barometer at sea, of which the observations on shore scarcely record a trace. For instance, in a storm at Madras on the 16th of May 1841, the hourly observations at the observatory gave the barometer 29·650 at $10\frac{1}{2}$ A.M., and the lowest depression was 29·513 at $4^h\ 41^m$ P.M., while the barque Tenasserim, which had been compelled to slip her cable and run to sea at 1 P.M., at 8 P.M., when not many miles distant from Madras, had the barometer at 28·60, the mercury at Madras at the same hour standing at 29·641, there being a difference of pressure of more than an inch of mercury *within a few miles*. The only effects of this storm upon the diurnal tide at Madras were, that the maximum nocturnal tide turned at $10^h\ 41^m$ P.M. instead of $9^h\ 41^m$ P.M., and the minimum ebb tide stopped at $2^h\ 41^m$ A.M. instead of $3^h\ 41^m$ A.M., but the minimum day-tide turned at the usual hour, 3^h 41 P.M.

Again, in a storm at Madras which took place on the 21st of May 1843, the simultaneous record of the barometer at the observatory and on board the General Kyd, which had been compelled to slip her cables and put to sea from Madras roads, was as follows:—

	Hours.											
	h m 12 41	h m 3 41	h m 5 41	h m 7 41	h m 9 41	h m 11 41	h m 12 41	h m 2 41 A.M.	h m 12 41	h m 2 41 P.M.	h m 5 41	23rd noon.
Madras	29·323	29·256	29·284	29·381	29·420	29·412	29·391	29·333	29·409	29·382	29·411	29·522
General Kyd	29·45	29·38	29·28	29·26	29·19	28·17	29·11	29·11	29·18	29·19	29·27	29·42

From this Table it is seen that at $11^h\ 41^m$ on the night of the 21st of May, the barometer stood respectively at Madras and on board the General Kyd at 29·412 and 28·17, a difference of 1·242; and as the General Kyd was only sixty-eight miles east of Madras at noon on the 22nd, this prodigious difference of pressure occurred within fifty or sixty miles. The daily atmospheric tides continued at Madras despite the storm. The barometer reached its maximum at $9^h\ 41^m$ A.M., 29·421; and at $3^h\ 41^m$ P.M. it had fallen to its minimum, 29·360; then as usual it rose to 29·498 at $9^h\ 41^m$ P.M., and

as usual fell gradually to 29·373 at 3^h 41^m A.M. Although therefore the general pressure of the atmosphere had been lowered three or four-tenths of an inch from the 20th and 21st of May, the daily tides had not been interrupted, the maxima and minima occurring at their usual hours. In a storm at Madras on the 24th of October 1842, the P.M. tide reached its maximum at 10^h 41^m P.M., but the ebb stopped at 1^h 41^m A.M. instead of 3^h 41^m A.M., and then rose until 9^h 41^m A.M., the duration of the ebb being three hours only, and the flow from 1^h 41^m A.M. to 9^h 41^m A.M., no less than eight hours; the next ebb six hours, and the subsequent flow seven hours. One other illustration will show how little the pressure of the atmosphere is affected at a great height by a proximate storm. On the 17th and 18th of April 1847 a great storm occurred on the Malabar coast. The following is the record of the barometer on the 17th, at different distances from the *centre of the storm*, as recorded by Colonel Reid; the Dodabetta observations being interpolated by myself.

	in.
Madras, 300 miles distant from centre, barometer . . .	29·97
Dodabetta, 166 miles distant from centre, barometer . .	21·917
Cannanore, 100 miles distant from centre, barometer . .	29·64
Ship Mermaid, 60 miles distant from centre, barometer .	29·35

On the 18th of April.

	in.
Madras, 400 miles distant from centre of storm, barometer	29·94
Bombay, 240 miles distant from centre of storm, barometer.	29·70
Dodabetta, 196 miles distant from centre of storm, barometer	21·984
Cannanore, 130 miles distant from centre of storm, barometer	29·78
Ship Buckinghamshire, 20 miles distant from centre of storm, barometer	28·35
Ship in centre of the storm, barometer	28·00

At the centre of the storm, distant from Cannanore 130 miles, the difference of pressure therefore was 1·78; at Dodabetta, at 8642 feet above the sea, and 196 miles from the Buckinghamshire, the greatest difference on the 17th, 18th, or 19th of April from the mean pressure of the month, was less than two-tenths of an inch, as the following records at Dodabetta show:—

1847. April 17.		April 18.		April 19.		Mean pressure of month of April.	
Barometer.	Oscillation.	Barometer.	Oscillation.	Barometer.	Oscillation.	Barometer.	Oscillation.
21·917	·058	21·984	·064	22·034	·044	22·097	·062

And although the wind at Dodabetta on the 17th and 18th blew from the east round to the west with a maximum pressure of 35 and 22 lbs., and with a mean pressure for the two days of 21 and 14 lbs.; and though ten inches of rain fell on the 18th, the daily atmospheric tides were neither suppressed, inverted, nor interrupted, and scarcely differed from the daily mean oscillation of the month. Sufficient instances have thus been

adduced of the comparatively narrow area of very great barometrical depressions, and the annual ranges given in the preceding Table may for the present be considered normal conditions, at least at Madras.

The following Table gives the monthly means of the diurnal oscillation of the barometer at Dodabetta, together with the monthly and annual range of the barometer, and the monthly fall of rain:—

Barometer at Dodabetta, at 8640 feet above the level of the sea.

	Barometer. Monthly means.		Difference.	Maximum.	Minimum.	Extreme monthly range.	Rain.
	$9^h\ 40'$ A.M.	$3^h\ 40'$ P.M.					
1847.	in.	in.		in.	in.		
February	22·129	22·068	·061	22·165	22·014	·151	7·43
March	22·160	22·105	·055	22·218	22·064	·154	3·61
April	22·128	22·066	·062	22·199	21·888	·311	19·80
May	22·087	22·024	·063	22·169	21·930	·239	4·86
June	21·992	21·940	·052	22·069	21·800	·269	4·55
July	22·000	21·949	·051	22·032	21·889	·143	7·41
August	22·030	21·976	·054	22·090	21·898	·198	9·32
September	22·031	21·977	·054	22·100	21·876	·224	7·52
October	22·086	22·014	·072	22·129	21·958	·171	12·49
November	22·117	22·038	·079	22·152	21·966	·186	11·85
December	22·073	22·013	·060	22·150	21·921	·229	12·28
1848.							
January	22·113	22·050	·063	22·163	22·016	·147	0·12
Year	22·079	22·019	·060	22·218	21·800	·418	101·24

Horary Oscillations.

It is thus shown that the mean daily range for the year is 0·060, and in no month of the year did it exceed 0·079 in. This is different from Mahabuleshwur, Poona, Madras and Bombay. At Mahabuleshwur, at 4500 feet, the mean diurnal oscillation for ten months, by simultaneous observations, was 0·0694, and in no month did the monthly mean exceed 0·0835. At Poona, at 1823 feet, for 1827, it was 0·1009, for 1828 it was 0·1075, and for 1829 it was 0·0991; but this last diminished oscillation is partly to be attributed to three months' observations having been taken at an elevation of 4000 feet above the sea; but in 1830 the barometers were stationed for the whole year at Poona, at 1823 feet, and the mean diurnal fall of the barometer from 9—10 A.M. to 4—5 P.M. was 0·1166; the mean of the four years was 0·1060. The greatest *mean* diurnal range for any month in those four years was 0·1616 in the month of December 1827. At Madras hourly observations were recorded from the years 1842 to 1845, both inclusive, and for ten months in 1841, of which I shall not take any account, as the year is incomplete. The mean monthly fall of the barometer from $9^h\ 41^m$ A.M. to $3^h\ 41^m$ P.M. daily, was respectively 0·124, 0·120, 0·122 and 0·121, exhibiting a singular uniformity, the differences being only in the thousandths of an inch of pressure. This uniformity is equally marked in the successive months of the several years, and I have gone through the labour of working out the details to show it, the Madras printed observations being a record of facts only without deductions or comment.

Mean Diurnal Horary Oscillations.

	Madras.				Bombay, 35 feet.		Calcutta, 18 feet.		Deccan, about 1800 feet.			Poona, 1823 feet.	Mahabuleshwur, 4500 feet.		Dodabetta, 8640 feet.
	1842.	1843.	1844.	1845.	1843.	1844.	Means. 1829–31.	1848.	1827.	1828.	1829.	1830.	1828–29.	Means, 15 years.	1847–48.
January	0·120	0·105	0·114	0·111	0·112	0·120	0·123	0·142	0·113	0·148	0·125	0·136	0·073	0·158	0·063
February ...	0·119	0·121	0·119	0·120	0·114	0·112	0·117	0·147	0·125	0·150	0·108	0·140	0·066	0·087	0·061
March	0·126	0·127	0·128	0·125	0·113	0·123	0·125	0·121	0·124	0·112	0·102	0·133	0·082	0·094	0·055
April	0·134	0·133	0·134	0·138	0·119	0·118	0·124	0·131	0·083	0·133	0·098	0·143	0·083	0·092	0·062
May	0·126	0·111	0·121	0·120	0·110	0·098	0·115	0·131	0·062	0·083	0·093	0·132	0·075	0·085	0·063
June	0·126	0·119	0·118	0·120	0·074	0·071	0·095	0·094	0·090	0·100	0·073	0·106	0·052	0·062	0·052
July	0·135	0·129	0·126	0·118	0·034	0·063	0·090	0·094	0·048	0·047	0·065	0·075	0·055	0·017	0·051
August	0·131	0·127	0·129	0·139	0·087	0·070	0·099	0·103	0·060	0·070	0·086	0·085	0·053	0·043	0·054
September ...	0·124	0·134	0·131	0·128	0·086	0·097	0·101	0·105	0·081	0·091	0·077	0·090	......	0·073	0·054
October	0·123	0·115	0·123	0·122	0·108	0·122	0·110	0·113	0·114	0·110	0·111	0·125	......	0·130	0·072
November ...	0·108	0·110	0·111	0·103	0·119	0·127	0·107	0·125	0·144	0·127	0·106	0·125	0·080	0·152	0·079
December ...	0·116	0·110	0·108	0·107	0·116	0·122	0·114	0·129	0·161	0·114	0·133	0·110	0·073	0·082	0·060
Year	0·124	0·120	0·122	0·121	0·099	0·095	0·110	0·097	0·102	0·109	0·099	0·116	0·069	0·089	0·060

Note.—The above means are the daily fall of the barometer from 9 to 10 A.M. to 4 to 5 P.M.

At Madras the mean daily oscillation would appear to have been least when the barometer was highest in November, December, or January; and the reverse of this was the case when the barometer was lowest in May, June and July. The *mean* of the four years, at Madras, in the months of highest pressure, December and January, is 0·111, and the mean of the four years in the months of least pressure 0·122. The mean daily oscillation therefore was greatest when the pressure of the atmosphere was least. The same was not observed to be the case in the observations made in the Dukhun in the years 1827, 1828, 1829 and 1830; the means for the two periods being 0·131 and 0·081; nor in Calcutta in the years 1829, 1830 and 1831, the oscillations being respectively 0·118 and 0·100; and in 1848 the difference was more marked, the means of the daily oscillation for the periods of greatest and least annual pressure being 0·135 and 0·106: the same was the case at Bombay and at Dodabetta. This peculiar feature exhibited at Madras is not satisfactorily explained by its not being subjected, like Calcutta and Bombay, to the south-west monsoon, because the general curve of pressure at Madras follows the order of pressure at Calcutta and Bombay, with the exception of the month of November in the years 1844 and 1845, when the mean monthly pressure was greater in that month than in December. The hourly observations at Madras were too systematically and apparently accurately taken to suppose there could have been inaccuracy in the records, and they are quite as trustworthy, if not more so, than any other meteorological records in India. There appears a great discrepancy in the mean daily range at Madras and Bombay in the months from March to November, particularly in the month of April, which does not belong to the monsoon of either place. In the other months, the small range at Bombay may be accounted for by the prevalence of the monsoon at Bombay and the absence of the monsoon at Madras, but the means of the daily range for the year indicate a greater oscillation at Madras than might have been expected.

Times of ebb and flow of the Atmospheric Tides, or Turning-points.

I have given separately the chief of the four daily tides, namely, the fall between 9—10 A.M. to 4—5 P.M., to facilitate comparison of the movements of the same tide at different places by simple inspection. The following Table gives the movements of the three other daily tides; but I have confined it to the Madras records, as three daily movements for various places could not have been put conveniently into juxtaposition.

Monthly means of the Daily Atmospheric Tides between the hours $3^h\ 41^m$—$4^h\ 41^m$ P.M. to $9^h\ 41^m$—$10^h\ 41^m$ A.M.

	Madras, 1842.			Madras, 1843.			Madras, 1844.			Madras, 1845.		
	$3^h 41^m$–$4^h 41^m$ P.M. to $9^h 41^m$–$10^h 41^m$ P.M.	$9^h 41^m$–$10^h 41^m$ P.M. to $3^h 41^m$–$4^h 41^m$ A.M.	$3^h 41^m$–$4^h 41^m$ A.M. to $9^h 41^m$–$10^h 41^m$ A.M.	$3^h 41^m$–$4^h 41^m$ P.M. to $9^h 41^m$–$10^h 41^m$ P.M.	$9^h 41^m$–$10^h 41^m$ P.M. to $3^h 41^m$–$4^h 41^m$ A.M.	$3^h 41^m$–$4^h 41^m$ A.M. to $9^h 41^m$–$10^h 41^m$ A.M.	$3^h 41^m$–$4^h 41^m$ P.M. to $9^h 41^m$–$10^h 41^m$ P.M.	$9^h 41^m$–$10^h 41^m$ P.M. to $3^h 41^m$–$4^h 41^m$ A.M.	$3^h 41^m$–$4^h 41^m$ A.M. to $9^h 41^m$–$10^h 41^m$ A.M.	$3^h 41^m$–$4^h 41^m$ P.M. to $9^h 41^m$–$10^h 41^m$ P.M.	$9^h 41^m$–$10^h 41^m$ P.M. to $3^h 41^m$–$4^h 41^m$ A.M.	$3^h 41^m$–$4^h 41^m$ A.M. to $9^h 41^m$–$10^h 41^m$ A.M.
Jan.	+0·078	−0·063	+0·105	+0·080	−0·069	+0·094	+0·078	−0·060	+0·096	+0·079	−0·062	+0·094
Feb.	+0·091	−0·068	+0·096	+0·084	−0·058	+0·095	+0·072	−0·049	+0·095	+0·083	−0·063	+0·100
March	+0·100	−0·064	+0·090	+0·094	−0·058	+0·091	+0·092	−0·055	+0·091	+0·097	−0·071	+0·099
April	+0·113	−0·056	+0·077	+0·103	−9·059	+0·089	+0·103	−0·048	+0·072	+0·116	−0·046	+0·075
May	+0·114	−0·064	+0·076	+0·096	−0·065	+0·080	+0·110	−0·059	+0·070	+0·100	−0·053	+0·073
June	+0·106	−0·046	+0·064	+0·098	−0·052	+0·073	+0·090	−0·038	+0·066	+0·105	−0·043	+0·058
July	+0·113	−0·046	+0·068	+0·103	−0·043	+0·076	+0·106	−0·052	+0·072	+0·102	−0·039	+0·057
Aug.	+0·110	−0·054	+0·075	+0·095	−0·046	+0·078	+0·107	−0·048	+0·070	+0·106	−0·036	+0·069
Sept.	+0·108	−0·059	+0·075	+0·101	−0·039	+0·072	+0·104	−0·048	+0·075	+0·105	−0·044	+0·067
Oct.	+0·101	−0·058	+0·080	+0·087	−0·058	+0·087	+0·097	−0·058	+0 084	+0·093	−0·050	+0·079
Nov.	+0·085	−0·063	+0·086	+0·091	−0·070	+0·089	+0·086	−0·059	+0·087	+0·096	−0·075	+0·083
Dec.	+0·087	−0·063	+0·092	+0·086	−0·067	+0·091	+0·091	−0·070	+0·087	+0·086	−0·048	+0·089
Means	+0·1005	−0·0587	+0·082	+0·0932	−0·0577	+0·0846	+0·0947	−0·0537	+0·0804	+0·0973	−0·0525	+0·0786

A close inspection of the hourly observations upon which the above Table of means is founded, shows that the tides turn occasionally on consecutive days at different hours, and the intervals between the maxima and minima in the several diurnal tides frequently vary from five hours to seven hours in the duration of each tide; and not less frequently it is found that at the turning-point or turn of the tide, there is no movement of the atmosphere at all

for an hour to an hour and a half; nevertheless the *monthly means* of the same tide for successive years are almost identical; take for instance the *rising* afternoon tide from 3—4 P.M. to 10 or 11 P.M. in the month of January, and it is seen that the means in the successive four years were ·078, ·080, ·078 and ·079, so that the daily irregularities were merged in the monthly means. Similarly, the rising tide from 3^h 41^m—4^h 41^m A.M. to 9^h 41^m—10^h 41^m A.M. in the month of February was ·096, ·095, ·095 and ·100 in successive years. The falling night-tide between P.M. and A.M. does not exhibit quite the same regular features; for instance, in the month of March we have ·064, ·058, ·055 and ·071. November also has ·063, ·070, ·059 and ·075; but the annual means of each tide, as in the great diurnal tide, remarkably approximate to each other in successive years, as is shown by the Table, which is worked out from the Madras hourly observations. Another feature exhibited by the Table is the alteration in the range of the monthly means of the diurnal movement of the same tide in different months of the year, the increment and decrement alternating at different seasons of the year with the increment and decrement of another of the tides; for instance, in the month of January throughout the four years the rising tide from 3^h 41^m —4^h 41^m P.M. to 9^h 41^m—10^h 41^m P.M. is LESS than the rising tide from 3^h 41^m—4^h 41^m A.M. to 9^h 41^m—10^h 41^m A.M.; but the reverse of this takes place as the year advances, and in April the P.M. *rising* tide is considerably greater than the A.M. rising tide, and this continues until November, when the previous relations return. The same remarks do not apply to the two *falling* tides, as the falling tide by day is invariably greater (more than double) than that of the falling tide by night.

In my paper on the Atmospheric Tides of the Deccan, I gave a Table (No. 3) of the anomalies in the period of the ebb and flow of the different tides in 1830, and to enable me to do this I had observed the barometer every five minutes about the period of the expected turn of the tide. The anomalies were numerous. In the Madras hourly observations the same anomalies are observable, as the intervals of maxima and minima vary from five hours to eight hours, although the absolute time of the turn of the tide within the hour is not shown. Dr. BUIST's observations in Bombay for 1843 and 1844 are also hourly, and exhibit the same occasional irregularities in the time of the tides turning as at Poona and Madras. The recent observations at Calcutta do not afford the means of detecting this no doubt existing fact; for observations at Calcutta are not recorded by night at all, and only every two hours during the day. A bare inspection of and reliance upon the Calcutta monthly tables therefore would justify the assertion that the daily maxima and minima in the oscillations of the barometer occurred at fixed hours, which, although generally true, is not absolutely so. The observations at Dodabetta were unfortunately not made hourly, with the exception of those for twenty-four hours between the twenty-first and twenty-second days of each month; the means of comparison therefore of the diurnal hourly oscillations with those of Madras and Bombay, are limited to those twenty-four hours in each month; but although so limited, features of interest are exhibited. It has hitherto I believe been supposed that the two ascending and two descending diurnal

tides of the atmosphere within the tropics, *although turning after a longer or shorter interval in each tide, were never interrupted or retrograde in the onward or backward movement of each tide.* The Dodabetta hourly observations indicate that such is not the case, and I have thrown the facts into a table for a comprehensive view of them.

Movements of the Atmosphere in twenty-four hours in each month (21st to 22nd) of the year 1847–48 at Dodabetta, at 8640 feet above the sea.

	Hours.																							
	A.M.			P.M.												A.M.								
	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11	Midnight.	1	2	3	4	5	6	7	8	9
Feb.	......	...	...	...	...	—·060	—·052	—·052	—·050	......	...	+·086	+·086	......	......	—·050	—·030	±·032	±·032	......	......	...	...	+·129
March	+·310	...	...	...	...	—·250	±·269	—·260	......	......	...	......	......	+·320	......	......	—·238	±·244	—·228					
April	+·130	...	...	...	...	......	—·078	......	......	......	...	+·118	+·118	......	......	......	......	......	—·048					
May	......	...	...	...	...	......	—·953	±·970	—·964	+·974	...	......	+·018	......	......	......	......	—·960	......	......	......	...	...	+·012
June	+·962	...	...	...	...	......	......	—·882	......	......	...	......	+·944	......	......	......	......	......	—·880	±·804	—·880			
July	+·026	...	...	...	...	......	—·960	......	......	......	...	......	+·015	......	......	—·968	±·970	......	—·950					
Aug.	......	...	...	...	...	......	—·022	......	......	......	...	......	+·073	......	......	......	—·030	—·030	—·030	......	......	...	...	+·084
Sept.	......	...	...	...	...	......	—·988	......	......	......	...	......	......	+·042	......	......	......	—·998	......	......	......	...	...	+·072
Oct.	+·128	...	...	...	...	—·028	......	......	......	......	...	+·040	......	......	......	......	......	—·040						
Nov.	......	...	...	...	...	......	......	—·056	......	......	...	......	+·100	......	......	......	......	—·058	......	......	......	...	...	+·133
Dec.	+·120	...	...	...	...	......	—·036	......	......	......	...	+·090	......	......	......	......	......	—·034	—·034					
Jan.	......	...	...	...	...	......	......	—·035	......	......	...	+·078	+·078	......	—·058	±·062	—·042	—·036	—·036	—·028	......	...	...	+·114

+ Indicates the maximum tide. — Indicates the minimum tide. ± Indicates an interruption to usual rise or fall.

The barometer ranged between 21·800 and 22·218 inches.

Observations on Horary Oscillations.

It is hence seen that in the month of March the diurnal tide, which usually falls from 10 A.M. until 4 P.M., turned at 3 P.M., and should then have gradually risen until 9—10 P.M., instead of which it rose only until 4 P.M. and then fell until 5 P.M., when it turned again and ran its usual course. In the same month the A.M. tide, which usually falls from 10 P.M. until 4 A.M., had its fall interrupted at 2 A.M. and rose until 3 A.M., when it turned and fell to its ordinary minimum, and then gradually rose until 10 A.M. In the month of May the daily minimum occurred at the proper hour, 4 P.M., and its ordinary regular rise continued until 5 P.M.; but at this hour it changed and fell until 6 P.M., but at that hour resumed its usual course. The other tides were free from these aberrations, but two of them turned at 3 and 9 A.M. instead of 4 and 10 A.M. In the month of June the flow is irregular in the 4 A.M. tide. Its minimum occurs properly at 4 A.M., and it rises until 5 A.M., but at this hour it has turned, instead of continuing to rise, and falls until 6 A.M., when the barometer is as low as at 4 A.M.,—a solitary instance within the year. In the month of January 1848, the falling tide from 10 P.M. goes on regularly until midnight, when it turns and rises until 1 A.M.; it then turns again in the proper direction, but instead of stopping at 4 A.M., the minimum hour, it continues until 5 A.M. and then turns. An inspection of the Table shows that the barometer never appeared to remain stationary at the turning hour of the maximum A.M. (9—10) tide, but that in the months of January, February and April, no movement of the tide took place for a full hour at the 9—10 P.M. maximum tide. In August, although the other tides flowed as usual, that of the A.M. period remained stationary from 2—4 A.M., both inclusive. The maximum A.M. tide occurred six times in six months of the year at 9 A.M., and six times in the other six months at 10 A.M. The maximum nocturnal tide took place only twice at 11 P.M., thrice at 9 P.M., five times at 10 P.M., and thrice was stationary between 9 and 10 P.M. The minimum diurnal tide turned once only at 6 P.M. The chief irregularities appear to have been in the A.M. minimum nocturnal tide, embracing the hours from 1—6 A.M. On looking over the Madras hourly observations for four years for the twenty-four hours between the 21st and 22nd of each month in the year 1842, there are *only two instances of similar irregularities.* On the 22nd of March in the falling A.M. tide at 2^h 41^m A.M., the barometer stood at 29·859, and at 3^h 41^m A.M., instead of continuing to fall, it had risen to 29·869, but at 4^h 41^m it resumed its regular course and fell to 29·865. On the 22nd of November an irregularity occurred in the nocturnal P.M. tide. At 10^h 41^m the barometer stood at 30·004; at 11^h 41^m it had fallen in due course to 29·991, but at 12^h 41^m it had risen to 29·992, and only at 1^h 41^m resumed its usual ebb, and fell to 29·981. In the year 1843 there are also *only two instances* of irregularity in the specified days; namely, on the 21st of August in the A.M. falling tide. At 1^h 41^m A.M. the barometer stood at 29·722; at 2^h 41^m, instead of falling, it rose to 29·725, then fell, at 3^h 41^m, to 29·724; then rose, at 4^h 41^m, to 29·726, and continued regular to the maximum period at 9 A.M. On the 21st of December, at 11^h 41^m

P.M., the barometer was 30·121; at 12^h 41^m, instead of continuing to fall, it had risen to 30·125, but then changed; and at 2^h 41^m it was 30·104, and fell regularly till 3^h 41^m A.M., when it was at its minimum, 30·089. On the 21st of September, in 1843, the minimum A.M. nocturnal tide occurred at 1^h 41^m A.M. instead of 3^h 41^m, at which hour it took place on the morning of the 22nd; the interval, therefore, between the minimum of this A.M. nocturnal tide and the maximum of the 9—10 morning tide, was seven hours, the maximum occurring at 8^h 41^m, a very rare instance of the continued flow of this A.M. tide, which usually runs its course within four or five hours, and on rare occasions in three hours; the change of pressure, however, was only equal to 0·114, from 29·763 to 29·877. In 1844 there is *but one instance* of irregularity within the prescribed hours. On the 22nd of September, at 12^h 41^m A.M., the barometer stood at 29·820; at 1^h 41^m it had fallen as usual to 29·808, but at 2^h 41^m it had risen to 29·819; at 3^h 41^m to 29·833; but at 4^h 41^m it had fallen to 29·832, and then continued regular. In 1845 there is also *only a solitary instance* on the 21st of March. At 7^h 41^m A.M. the barometer stood at 29·933; at 8^h 41^m it had fallen, instead of rising, to 29·932, but at 9^h 41^m resumed its usual course. It will be remarked that at Madras there is *not a single instance* of irregularity in four years in the fall of the great diurnal tide from 9—10 A.M. to 4—5 P.M., and the instances of irregularities in the other tides only serve to prove that the laws are not without exceptions. From the above comparisons it is seen that the irregular movements in the tides were not common to Dodabetta and Madras at simultaneous periods of time, nor at proximate periods of time. The irregularities in the intervals of the different tides are numerous, as are also the instances of stationary periods in which the atmosphere appears to be quiescent from one to two hours. It now remains to notice the deviations from the usual laws at Bombay, as recorded by Dr. BUIST in his Bombay hourly observations for 1843 and 1844. On the 21st of January, at 3 A.M., the barometer stood at 29·864, at 4 A.M. at 29·865; but at 5 A.M., instead of continuing to rise, it had fallen to 29·863, and continued to fall until 6 A.M., when it stood at 29·856; at 7 A.M. it resumed its usual course, and continued to rise until the maximum hour. At Madras, on the same day, making allowance for the difference of longitude, *nothing of the kind occurred.* At Bombay, on the 21st of March, at 11 P.M., the barometer stood at 29·688; but at midnight, instead of continuing to fall, it had risen to 29·699, and it was only at 1 A.M. it resumed its ebb. *There was nothing of the kind at Madras,* where the maximum, 29·861, was attained at 10^h 41^m with the ordinary regularity. On the 22nd of May, at Bombay, there were irregularities in all the tides, a thing so unusual, and not occurring at all on the 20th or 23rd of May, as to render the table apocryphal, either from error in the record or in the lithography; the A.M. falling tide stops at 2 A.M., then rises to 8 A.M., falls to 9 A.M., and then rises to 10 A.M., its maximum, however, being at 8 A.M. From 4 P.M. the tide as usual rises to 6 P.M., then falls to 8 P.M., and afterwards proceeds to attain its maximum at 11 P.M. Something similar occurs between 1 and 5 A.M. on the 21st of June, but not on the 22nd. *Nothing of the kind occurs at Madras, either on the*

20th, 21st, 22nd or 23rd of May. The last irregularity to be noticed at Bombay, within the limit hours, was on the 21st of October. At midnight the barometer stood at 29·803; at 1 A.M. it had risen in the usual course to 29·887, but at 2 o'clock it had fallen to 29·881, and only resumed its ordinary rise at 3 A.M.; as far as the record goes, there does not appear to have been any irregularity at Madras*. Similar instances occur within the limit hours in 1844,—on 21st of January at 3 A.M., 21st of May at 1 A.M., when the tide remained stationary at $3^h\ 41^m$, and 5 A.M., and at 1 A.M. on the 22nd of December. In September the maximum horary pressure occurred at $11^h\ 30^m$ A.M., and in other months several times at 11 A.M.

If we extend our comparisons to Aden, on the coast of Arabia, nearly in the latitude of Madras, but 35° 6′ of longitude to the west of Madras, we find the very same exceptions to normal conditions. Dr. BUIST has been kind enough to transmit to me proof sheets, now going through the press, of part of a meteorological journal kept at Aden for 1847 and 1848. Hourly observations were taken on certain term-days monthly; instead of taking up the whole of these term-days, it will suffice to select those of January and June of each year, these being months in which the maximum and minimum pressure of the atmosphere usually occur in India. Barometer 187 feet above the sea at Aden. All corrections made.

January, 1847.	Hours.																									Means.
	P.M.													A.M.												
	Noon.	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
15	29·760	...	...	·743	...	...	...	...	...	·821	...	...	·778	·780	...	·770	...	...	...	...	...	...	·853	...	...	29·790
25	29 684	...	...	·661	...	...	...	...	·717	...	...	...	...	...	...	·646	...	...	...	...	...	...	·743	...	...	29·691
30	29·763	...	...	·716	...	...	...	...	...	...	·786	...	...	...	...	·722	...	...	...	...	...	·808	...	...	...	29·760
June, 1847.																										
8	29·648	...	...	·557	...	...	...	...	...	...	·637	...	...	...	...	·583	...	...	...	...	...	...	·698	...	...	29·614
16	29·582	...	...	·488	·488	...	...	...	...	·542	...	...	...	...	...	·507	...	...	...	...	...	...	·613	...	...	29·533
20	29·631	...	...	·502	...	...	...	...	·574	...	...	...	...	...	...	·506	...	...	...	...	...	...	·620	...	...	29·552
29	29 490	...	...	...	·385	...	...	...	...	...	·484	...	...	...	...	·431	...	...	...	...	...	...	·548	...	...	29·468
January, 1848.																										
7	29·856	...	·810	...	...	...	...	...	...	·921	...	...	·858	·864	...	·844	...	...	...	...	...	·914	...	...	...	29·876
14	29·868	...	...	·835	...	...	...	...	...	...	·902	...	...	...	...	·860	...	...	...	...	...	·915	...	...	...	29·874
24	29·791	...	...	·732	...	...	...	...	...	...	·807	...	...	...	...	·733	...	...	...	...	...	·853	...	...	...	29·781
28	29·774	...	·720	·720	...	...	...	...	...	...	·814	...	...	...	...	·761	...	...	...	...	...	...	·853	...	...	29·781
June, 1848.																										
8	29·497	...	...	·416	...	...	...	...	...	...	·507	...	...	...	·395	...	...	...	...	...	...	·532	...	...	...	29·460
15	29·546	...	...	·481	...	...	...	...	...	·549	...	...	...	...	...	·479	...	...	·572	·563	...	...	...	·609	...	29·533
21	29·522	...	...	·382	·382	...	...	...	...	·469	·446	·466	·462	...	...	·377	...	...	...	...	...	...	·567	...	...	29·456
29	29 651	...	...	·542	...	...	...	...	...	...	·599	...	...	...	...	·544	...	...	...	...	...	·673	...	...	...	29·589

A glance of the eye over the above Table shows the turning-points of the several tides and their irregularities. The first marked feature is the almost constant turning of the descending P.M. tide and ascending A.M. tide at 3 P.M. and 3 A.M., instead of at 4 or 5 P.M. and A.M., as on the continent of India; to this there are only five

* In a diagram of the comparative readings of seven barometers at Bombay, between the 20th and 21st of June 1843, these anomalies appear to have occurred between 2 and 3 P.M., 7 and 8 P.M., 10 and 11 P.M. and 1 to 4 A.M., but the barometers did not exactly harmonize in their movements.

exceptions to the former and only one to the latter; but two of the exceptions are remarkable, the tide having turned on the 7th and 28th of January 1848, at 2 P.M. I do not recollect a single case of the kind in the records in India. In the first of these cases the tide flowed from 2 until 9 P.M., seven hours; and in the second it remained stationary from 2 until 3 P.M., and then flowed until 10 P.M.; this portion of the diurnal movement of the atmosphere occupying eight hours instead of six. As a contrast to these lengthened periods, we find that the 3 P.M. ascending tide, on the 25th of January and 20th of June 1847, flowed only from 3 P.M. until 8 P.M., five hours instead of eight. On the 15th of January 1848, the ascending A.M. tide did not attain its maximum until 11 A.M., but this retardation was probably owing to an inversion in the flow at 7 A.M.; the pressure, instead of increasing at this hour, having diminished from 29·572 at 6 A.M. to 29·563, but after this interruption the usual increase took place up to 11 A.M. It will be seen that there are two instances of a stationary state of the barometer on the 28th of January 1848, from 2 to 3 P.M., and on the 21st of June 1848, from 3 to 4 P.M. Meteorologists know that this circumstance, which would excite no attention without the tropics, is of rare occurrence within the tropics. The next great feature in this Table is the absence of any retrograde movement in the P.M. descending and ascending tides; but this is not the case with the other two tides; as at Dodabetta, several interruptions in the flow or ebb are recorded. In the descending nocturnal A.M. tide there are three instances. On the 15th of January 1847, at 1 A.M., the tide has risen from midnight instead of continuing to fall. Precisely the same thing occurs on the 7th of January 1848, at the same hours. On the 21st of June the interruption occurs at an earlier hour. The pressure is at its maximum at 9 P.M.; it then diminishes until 10 P.M., but instead of continuing to diminish it increases until 11 P.M., but at midnight has resumed its usual course. In the A.M. ascending tide there is only one instance of inversion; on the 15th of June 1848, the usual rise stops at 6 A.M. and retrogrades until 7 A.M., it then resumes its usual flow and continues until 11 A.M., a very unusual hour for the period of the maximum of the A.M. tide. Had the term-days of the other months been noticed, numerous instances of deviations from normal conditions could have been given. *It would be desirable to ascertain whether these aberrations have any relation with changes in the electrical tension in the atmosphere.*

If these anomalies be tested by a comparison with hourly readings of the barometer, at Aden CORRECTED FOR THE TENSION OF VAPOUR*, for four days in each month of the year 1847, not only is their occurrence rendered unquestionable, but new phases in abnormal conditions appear. Annexed is a Table of the "Means" of hourly readings of the barometer in four days in each month at Aden in 1847, CORRECTED FOR MOISTURE.

* Corrected by the observer.

Means of the Hourly Readings of the Barometer at Aden for 1847, corrected for Moisture.

	Noon.	P.M.												A.M.												Means.
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
Jan.	28·969	...	·954	......	...	...	...	...	...	29·018	......	......	......	28·973	...	......	......	...	......	...	...	...	29·063	...	...	28·996
Feb.	29·118	·121	...	......	...	...	...	...	...	......	29·171	......	......	......	...	29·110	......	...	......	...	...	...	29·188	...	...	29·132
March	29·051	...	...	·005	...	...	...	...	...	......	·081	......	......	......	...	......	30·020	...	......	...	...	·103	......	...	...	29·052
April	28·914	...	...	......	·867	...	...	·896	·878	......	·904	......	......	......	...	·870	......	...	......	...	...	...	·931	...	...	28·893
May	28·729	...	...	·643	...	...	...	·691	·686	......	·717	......	......	......	...	......	·667	...	·739	·722	...	...	·738	...	...	28·702
June	28·679	...	...	......	·550	...	·634	·684	...	·654	·634	·664	......	......	...	......	......	·554	......	...	...	...	·667	...	...	28·624
July	28·655	...	...	......	...	·715	...	...	...	......	......	......	......	·590	·599	·591	......	...	·667	·613	...	...	·656	...	...	28·639
Aug.	28·709	·707	...	......	...	...	...	·777	·747	·758	......	·695	·744	·727	·714	·717	·704	·676	......	...	...	...	·836	...	...	28·735
Sept.	28·739	·784	...	·733	...	·762	·746	...	...	·765	......	......	......	·715	...	......	......	...	·775	·751	...	·760	......	...	...	28·748
Oct.	29·011	...	...	28·933	...	...	...	...	...	......	29·051	29·032	29·068	......	...	29·031	......	...	29·166	...	...	...	......	...	...	29·032
Nov.	29·195	...	...	·135	...	...	...	...	...	......	·309	......	......	·252	·252	......	......	...	·311	...	...	·262	·269	...	...	29·239
Dec.	29·259	...	...	·174	...	...	...	...	...	......	·292	......	......	......	...	·240	......	...	......	·280	·275	...	·307	...	...	29·253

It has been asserted that when the barometer is corrected for moisture its diurnal movements in the tropics are resolvable into a simple ascending and descending curve in the twenty-four hours, nevertheless the first feature of the Table is the existence of two ascending and two descending tides, although the correction for moisture had reduced the air in which the mercurial column had moved to a supposed dry state. The usual hours of the ebb and flow are generally sufficiently manifest, particularly in the hours of greatest pressure, yet there is the unusual circumstance of the ascending A.M. tide turning in five months at 6 A.M. instead of 9—10 A.M., and in this tide also there are three instances of a check to its usual movements. The ascending P.M. tide has also its anomalies. In eight months it attained its maximum at the usual time between 9 and 10 P.M., but in July there is the rare circumstance of its turning at 5 P.M. instead of 9—10 P.M., and in June and August the equally rare circumstance of its turning at 7 P.M.; the next anomaly in this tide is in October, when it did not turn until midnight. The chief anomalies, as at Madras, Bombay and Dodabetta, occur in the A.M. and P.M. ebb or descending tide. The Table shows that the turning-points of the P.M. diurnal ebb, ranged from noon in February, and July, to 4 P.M. in April and June. In February, when the minimum occurred at noon, the maximum took place at the usual hour, 10 P.M.; there was therefore the almost unprecedented circumstance *of a tide continuing to flow for nine hours*. In the A.M. descending or ebb tide, the anomalies are even more marked than in the corresponding P.M. tide, for the turning-points range from 1 A.M. to 5 A.M. In January it turned at 1 A.M., and then the ascending tide continued to flow uninterruptedly until 10 A.M., a second instance of a *nine hours' flow*. In July, September and November, it also turned at 1 A.M., but the maximum occurred at 6 A.M. instead of 10 A.M., the flow in each of these months being five hours! a glance of the eye over the Table will show; although the different tides ultimately attained their respective maxima and minima, yet in many instances they were subject to checks or interruptions, which appeared to give way after a short resistance to the periodic movements of the atmosphere. In the month of August, however, the atmosphere appeared in so vacillating and disturbed a state, that the only tide which turned at the normal hour was the 10 A.M. maximum tide. The means of the hourly readings on four days in each month, corrected for moisture, give a mean curve of pressure in each month which nearly corresponds with the curve of pressure of the daily readings of the barometer corrected for temperature only. The maximum pressure with both corrections occurs in December, but the minimum occurs in June corrected for temperature and in July with both corrections. The whole of the facts connected with the meteorology of Aden of which I have made use, are from observations taken by Sergeant Moyes, with excellent instruments, and Dr. Buist is now passing the observations through the press.

These facts, which could be very greatly multiplied, have been somewhat dwelt upon, with a view to a right understanding of Humboldt's observations in his Cosmos*,

* Bohn's Edition, vol. i. p. 320.

where, speaking of the horary oscillations of the barometer, he says, "their regularity is so great, that in the day-time especially, the hour may be ascertained from the height of the mercurial column without error, on the average of fifteen or seventeen minutes. In the torrid zones of the new continent, on the coasts, as well as at elevations of nearly 13,000 feet above the level of the sea, where the mean temperature falls to 44°·6, I have found the regularity of the ebb and flow of the aërial ocean undisturbed by storms, hurricanes, rain and earthquakes." It is now shown that the horary oscillations have a different range in different months of the year; their range is influenced by height above the sea, and the tides do not always flow and ebb in equal periods of time; but the existence of two ascending and two descending but unequal tides within twenty-four hours within the tropics, is established beyond all question; and if not altogether *undisturbed*, as HUMBOLDT says, by storms, hurricanes or rain, yet the meteorological records in India prove that the periodic daily movements of the aërial ocean are never suppressed*.

Pressure of the Atmosphere.

With respect to the mean pressure of the atmosphere in India near the sea-level, I shall limit myself to the insertion of a comparative *table* showing the means of four years' hourly observations at Madras, the means of two years' hourly observations at Bombay, and the observations taken every two hours (but during the day only) at Calcutta, for 1843–44 and 1848. I append however curves of pressure at these places projected for longer periods, and for which I am indebted to Dr. BUIST, LL.D. The barometers at these respective localities, being each only a few feet above the sea-level, should have differed from each other in their mean annual results only in the third place of decimals, or at most only slightly in the second place of decimals, nevertheless the pressure at Bombay differs from that at Madras a twentieth of an inch; and at Calcutta, where the barometer is 17 feet nearer the mean sea-level than at Bombay, the mean annual pressure is even less than at Bombay, while on the other hand the pressure at Aden reduced to the sea-level is greater than anywhere else. These discrepancies originate probably in the neglect of using previously compared instruments. At Madras, the annual means in successive years differ from each other only in hundredths of an inch. For the mean pressure at different elevations tables are annexed.

* The observations of Lieut. R. STRACHEY in Thibet, at 18,400 feet above the sea, show that on the 22nd and 23rd of August 1849, the following were the oscillations of the four tides:—

	B. uncorrected for temperature.	B. corrected for temperature.
5 P.M. to 11 P.M.	+·059	+·075
11 P.M. to 4 A.M.	—·033	—·029
4 A.M. to 10 A.M.	+·043	+·016
10 A.M. to 3 P.M.	—·037	—·032

Monthly Mean Pressure of the Atmosphere, reduced to 32°.

	Madras.				Bombay, 35 feet.		Calcutta, 18 feet.		Aden, 187 feet.		Poona, 1823 feet.	Mahabuleshwur, 4500 feet.		Dodabetta, 8640 feet.	Royal Observatory, Greenwich, 159 feet.
Years....	1842.	1843.	1844.	1845.	1843.	1844.	1848.	1843, 1844.	1847.	1848.	1830.	1828, 1829.	Means of 1 year.	1847, 1848.	Means of 8 years, 1841 to 1848.
January.	29·995	29·985	29·998	30·015	29·923	29·947	30·000	29·937	29·774	29·872	28·087	25·465	25·737	22·081‡	29·766
February	29·972	29·966	29·980	29·965	29·889	29·928	29·980	29·915	29·832	29·853	28·002	25·452	25·765	22·098	29·737
March...	29·860	29·886	29·907	29·924	29·839	29·869	29·838	29·793	29·770	29·783	27·952	25·576	25·688	22·132	29·750
April ...	29·805	29·864	29·809	29·818	29·813	29·804	29·716	29·656	29·690	29·711	27·907	25·538	25·667	22·097	29·708
May ...	29·713	29·692	29·700	29·712	29·662	29·750	29·636	29·563	29·635	29·584	27·846	25·467	25·643	22·055	29·785
June ...	29·664	29·709	29·668	29·705	29·654	29·628	29·516	29·184	29·545	29·511	27·768	25·377	25·664	21·966	29·797
July ...	29·697	29·709	29·723	29·726	29·661	29·648	29·528	29·517	29·491	29·475	27·766	25·319	25·600	21·974	29·799
August..	29·729	29·759	29·731	29·742	29·730	29·701	29·571	29·516	29·540	29·483	27·840	25·387	25·647	22·003	29·787
Sept. ...	29·768	29·788	29·793	29·830	29·779	29·795	29·713	29·662	29·639	29·626	27·925	......	25·524	22·004	29·809
October	29·873	29·863	29·868	29·850	29·845	29·825	*29·881	29·633	29·811	29·745	27·923	......	25·810	22·050	29·858
Nov. ...	29·941	29·926	29·963	29·984	29·887	29·924	30·005	29·867	29·897	29·855	28·018	†25·500	25·733	22·077	29·714
Dec. ...	30·201	30·001	29·926	29·965	29·961	29·893	30·021	29·951	29·902	29·876	28·068	†25·498	25·739	22·043	29·857
Means of year	29·8515	29·8457	29·839	29·853	29·805	29·809	29·783	29·707	29·711	29·698	27·925	......	25·684	22·046	29·781

The mean monthly pressure at Calcutta for 1843–44 is from reductions of Dr. M'Clelland, and the record commences in November 1843 and ends in October 1844. An inspection of the above Table shows that the maximum mean monthly pressure does not occur in the same month in successive years. At Madras, in 1842 and 1843, the maximum pressure was in the month of December, in the two following years it was in the month of January. At Bombay, in 1843, the maximum was in December, in 1844 in January, at Calcutta, in 1843, in December, and in 1848 it was in December. At Madras the minimum monthly mean pressure, in three years out of the four, occurred in the month of June. In 1843 it was in the month of May, but at Bombay in the same year in June: at Bombay and Calcutta in 1844, and in 1848, at Calcutta, it took place also in June. At Poona, at 1823 feet, the maximum was in January and the minimum in July. At Dodabetta, at 8640 feet, unlike any of the stations at the sea-level, the maximum mean monthly pressure took place in March: the same thing occurred at Mahabuleshwur§ in 1828–29, at 4500 feet above the sea; but like the other stations the minimum pressure at Dodabetta occurred in June, but at Mahabuleshwur in July. Dr. Buist of Bombay mentions that for three years at Aden (1846–48) the minimum occurred in July, and the maximum in February, but by the preceding Table the maximum in 1847 and 1848 occurred in December, and the minimum in both years in July. At Greenwich the means of thirty years' observations, recorded in Belville's Manual, give results inverse to those in India, as the maximum pressure is in June and the minimum in November; but there is a second maximum in January and a second minimum in March; but the greatest *daily* mean pressure occurs about the 9th of January, and

* Thirteen days' observations wanting.

† For 1828, remaining months for 1829.

‡ For 1848, remaining months for 1847.

§ The means of one year's pressure at Mahabuleshwur is inserted from the Bombay Medical Journal, but the observations do not appear to have been corrected for temperature, and as the maximum pressure is represented to occur in October and the minimum in September, there evidently must be some mistake, and I therefore only notice my own simultaneous observations with Dr. Walker for 1828–29.

the minimum daily mean depression at the end of November. From the means of eight years' observations, obligingly furnished to me by Mr. GLAISHER, from the Royal Observatory, Greenwich, the maximum was in October; with a second maximum in December, the minimum was in April; corrected however for the tension of vapour, the maximum was in December and the minimum in August; but consecutive years differ greatly when the vapour correction is applied.

I attempt no explanation of these anomalies, as much more lengthened observations are required than those at my disposal afford for philosophical deductions. From the month of the maximum pressure, there is a gradual mean monthly decline of pressure until the minimum pressure; then there is a gradual monthly increase of pressure, even when the monsoon sets in at Madras in October until the maximum is attained again; but there is no rule without an exception, and the curve was interrupted in the month of December in the years 1844 and 1845 at Madras, and in 1844 at Bombay; but in Calcutta, in October 1844, and at Mahabuleshwur, and at Dodabetta in December 1828 and 1847 respectively. At Aden, in 1847, it was interrupted in February. In 1848 the curve was regular.

Appended to this paper are annual pressure curves at Madras, Bombay and Calcutta, protracted from the records of the barometer at the several places. The three localities are under very different conditions of temperature and moisture in the same months, and they differ considerably in latitude and longitude; Madras and Bombay, situated upon opposite sides of the peninsula of India, are subject to different monsoons; Madras to the N.E. monsoon, which commences in October and ends in February, and Bombay is subject to the S.W. monsoon, which commences in June and ends in October. Calcutta is under the full influence of the S.W. monsoon, but has occasional showers from the Madras rains. When Bombay is deluged with rain Madras is comparatively dry, and the hot weather prevails; and when Madras is under the influence of the Coromandel rains, Bombay is cold and dry. Very different atmospheric conditions therefore exist at the two places in the same months. Nevertheless the annual curves of pressure protracted from monthly means, may be said to be identical, not only for Madras and Bombay, but also for Calcutta. The few exceptional cases are lost or disappear in the means, and may originate in local causes. It would thus appear that the periodic movements of the *mass* of the atmosphere within the northern tropic are independent of, or only very slightly affected by, the hygrometric and thermometric conditions of the *lower strata of the atmosphere.* It occurs to me that this phenomenon may be owing to the sun's place in the ecliptic. When the sun is at the southern tropic, the air above the northern tropic is comparatively cold and therefore dense, and at its greatest pressure; this would be from December to January inclusive. As the sun returns to the north the air gets gradually warmer and dilates, and the pressure being inversely as the volume, the barometer gradually sinks, until the sun is returning from the northern tropic again, when the mass of the atmosphere gradually cools, gets denser, and the pressure gradually increases again. Supposing this explanation to have any foundation in truth, the curve of pressure within the tropic south of the equator would be the reverse of that in the tropic north of the equator. The maximum pressure would be from June to July inclusive,

and the minimum pressure from December to January inclusive. On referring to the St. Helena observations for 1843 this is very nearly the case, the maximum pressure and minimum temperature being in August instead of July, and the minimum pressure and maximum temperature in February to March instead of January.

Meteorological Observations at St. Helena, 1843.

	Barom. in.	Therm. °
January . . .	28·238	64·76
February . . .	28·214	66·25
March	28·214	65·35
April	28·251	64·93
May	28·292	61·53
June	28·335	58·88
July	28·341	57·43
August	28·358	56·71
September. . .	28·328	56·92
October . . .	28·279	57·23
November. . .	28·250	59·54
December . . .	28·251	62·44*

From the occurrence of the maxima and minima of the horary oscillations of the barometer at the same *local hours* in different meridians, these phenomena also would seem to be connected with the sun's action upon the atmosphere.

In the fitful movements of the atmosphere beyond the northern tropic the sun's influence would not appear to be similarly felt, as the maximum pressure at Greenwich is in October, with a second maximum in December, and the minimum pressure, instead of being when the sun is at the northern tropic, is in November.

Temperature.

The hourly observations at Madras for four years afford the most complete and trustworthy data for determining at that place the fluctuations of temperature, the exact diurnal and annual range, and the exact periods of the fluctuations in the occurrence of the maxima and minima, which cannot be satisfactorily shown by any observations short of hourly record. For Bombay I have only such records made by Dr. Buist for the years 1843 and 1844. Those at Calcutta were two-hourly only during the daytime, and those at Dodabetta were made but twice a day, with the exception of twenty-four hours once a month between the 21st and 22nd, when the observations were taken hourly. For exact determinations I am constrained to abandon many proposed comparisons, and in many instances to use less frequently recorded observations to express general features. The following Table shows the monthly means and annual temperatures at Madras and Bombay from hourly observations. For the other localities the means are derived from less frequent observations, and are therefore only approximations to the truth.

* The above table is confirmed by the Mauritius and Cape observations; the minimum pressure being from January to February inclusive, and the maximum July to September inclusive.

Monthly Mean Temperatures at Madras and Bombay from Hourly Observations, and at Calcutta and elsewhere from less frequent periods of record.

	Madras.				Bombay, 35 feet.		Calcutta, 18 feet.				Aden, 187 feet.	Phulton, about 1700 feet.	Bijapoor, about 1700 feet.	Poona, 1823 feet.	Sattarah, 2320 feet.	Mahabuleshwur, 4500 feet.			Mercara, Coorg, 4500 feet.	Uttra Mullay, 4500 feet.		Dodabetta, 8640 feet.
	1842.	1843.	1844.	1845.	1843.	1844.	1845.	1846.	1847.	1848.	1848.	1847.	1848.	1830.	Means of 1844–47.	1828–29.	1834.	1829 to 1843.	Means of 1838–40.	1845.	1846.	1847–48.
Jan.	76°·98	77°·59	75°·71	76°·81	76°·4	74°·9	76°·52	75°·72	75°·95	73°·70	72°·6	74°·8	78°·7	75°·4	70°·0	65°·38	65°·70	64°·0	66°·6	62°·08	63°·42	52°·20
Feb.	77·92	77·90	77·74	79·41	78·1	76·0	78·55	76·78	76·08	80·20	73·4	76·9	75·3	78·85	72·6	68·30	67·50	66·3	70·80	64·25	65·75	52·30
March	82·36	81·52	82·20	83·13	79·9	79·3	89·05	87·85	87·90	88·08	76·8	83·9	84·8	85·9	77·8	74·68	74·00	71·5	73·7	69·58	65·58	54·55
April	85·67	85·19	86·34	86·58	84·3	83·9	87·97	91·85	88·60	88·08	80·6	83·9	88·4	87·95	80·6	75·71	74·40	74·5	73·1	68·42	67·83	56·20
May	88·09	85·02	86·98	88·63	85·9	85·7	90·67	88·67	89·93	91·80	84·8	86·1	88·5	86·70	80·1	74·79	73·90	72·4	71·9	67·83	65·33	57·20
June	88·05	85·52	88·58	86·64	85·4	85·0	88·12	87·00	87·50	89·85	85·5	81·2	85·0	83·65	77·0	68·08	66·30	66·3	69·1	65·08	62·33	52·50
July	86·68	85·79	85·76	86·12	83·1	81·8	86·25	86·88	85·88	86·03*	83·4	80·2	81·2	76·95	73·8	65·43	64·90	63·2	67·1	66·00	63·83	52·65
Aug.	84·45	84·51	85·25	85·88	81·1	81·4	85·20	86·28	85·82	85·18*	81·5	79·3	78·7	76·85	73·0	64·60	65·30	63·2	66·0	66·66	64·42	53·10
Sept.	82·36	84·26	82·97	83·91	81·2	80·5	87·70	85·35	85·66	86·10*	84·9	78·9	78·2	78·35	74·0	64·34	65·00	63·9	65·6	67·50	64·92	52·45
Oct	81·86	80·72	80·53	82·95	82·3	83·4	85·30	83·70	84·58	83·55*	83·4	80·0	76·6	80·65	76·1	65·68	65·50	66·6	66·8	65·58	63·42	53·30
Nov.	78·27	77·83	79·17	79·11	80·2	80·4	80·42	80·65	77·88	78·50*	78·5	73·5	76·7	77·15	72·0	64·76	63·50	64·4	66·5	65·58	63·92	52·15
Dec.	76·57	75·89	76·94	77·70	76·6	79·3	73·55	73·08	73·28	75·30*	77·2	72·9	79·2	75·05	71·8	63·56	62·30	63·2	64·4	63·50	63·17	50·80
Year	82·44	81·81	82·35	83·07	81·2	80·9	84·11	83·65	83·26	83·86	80·2	79·2	81·7	80·28	75·0	67·52	67·30	66·60	68·6	66·00	64·49	53·20

* Means of two-hourly observations. The mean temperature at Madras, in 1848, was 83°·15, and the curve the same as that of the preceding years.

Sattarah is in Lat. 17° 40′. Long. 74° 2′. Mercara is sixty-five miles E. of Cannanore. Uttray Mullay, twenty-two miles N.E. by E. from Trevandrum.

The mean temperature at Mahabuleshwur, from 1829 to 1843, was deduced from the *mean* of a daily maximum and minimum thermometer in the shade.

The first feature is the close approximation of the annual means at Madras for the four years; the difference between the greatest and least being only 1°·26 FAHR., although the difference between the means of the same month in successive years may have exceeded three degrees. Nevertheless the means of most of the months in successive years show a great amount of uniformity. The coldest months are December or January, and the hottest May or June. In 1842 and 1843 December was the coldest month. In 1844 and 1845 January was the coldest. In 1842 and 1845 May was the hottest month. In 1843 the maximum mean heat was not reached until July, and in 1844 it occurred in June. Although these discrepancies occur, the monthly increment or decrement to or from the maximum period is gradual, and rarely checked or inverted. In Bombay the annual mean temperature for 1843 is almost identical with that of Madras for 1843, although the two places differ 5° 41′ in latitude. The monthly means of the two places correspond tolerably well from January until July; for instance, February corresponds within a tenth of a degree, and June within two-tenths. But in July there is a difference of 3°·79, August 3°·31, September 3°·16, Madras being plus: then the sign changes and Bombay becomes plus for the remaining months of the year, and also in January. The coldest month in Bombay was January, and the hottest May. In Bombay, in 1843 and 1844, unlike Madras, there is an inversion in the decrement of heat on the sun's going south; for October is represented as hotter than September in both years: a very remarkable fact is exhibited by these hourly means, *namely, that neither the south-west monsoon at Bombay, nor the north-east monsoon at Madras, at all affect the monthly mean regular increment or decrement of heat*, with the exception of October in Bombay. It will be observed that the maximum heat, both at Madras and Bombay, was not when the sun was vertical at either place passing to the northern tropic; but when the sun was near to the northern tropic in June, the mean temperature in 1843 at Madras, in lat. 13° 4′, was at its maximum in July, while at Bombay, in lat. 18° 55′, the greatest heat was in May of that year; and though the sun passes over both places again to the south the mean temperature gradually declines in each year, with the exceptions noticed. I was desirous of inserting in the Table of Mean Temperatures those for 1843 and 1844 at Calcutta, for comparison with the Madras and Bombay observations for the same year; but on referring to the volumes of the Bengal Asiatic Researches for 1843 and 1844, I found that the tables had not been inserted. They were met with however in the Journal of the Horticultural Society of Calcutta, but proved to be records of the temperature during the day only at 9½ A.M., noon, 4 P.M. and sunset*. A mean temperature from such data would neces-

* In the fifth volume of the Calcutta Journal of Natural History, Dr. M'CLELLAND states that the mean temperature of 1844, from daily observations, was 82°·35, the coldest period at sunrise, and the hottest at $2^h\ 40^m$ P.M. daily; the maximum heat 104° on the 10th of April, the minimum 51°·7 on the 19th of January, and the annual range 52°·3. He speaks also of the minimum daily pressure of the barometer occurring twice at 6 P.M. in January, February and May.

sarily be unsatisfactory. In 1847 meteorological tables appear in the Journal of the Asiatic Society of Bengal from the same source as those used by the Horticultural Society in the preceding years, namely, from the office of the Deputy Surveyor-General in Calcutta, but they were even of less use than the preceding tables, for they had but two daily records, namely, at 9½ A.M. and 4 P.M., and the records were otherwise useless for determining the absolute range of the thermometer, as there was only a record of the maximum temperature and no minimum. In 1848 more elaborate tables make their appearance, containing two-hourly records from sunrise to sunset, at sunrise, 9½ A.M., noon, $2^h\ 40^m$ P.M., 4 P.M., and sunset, together with the indications of a maximum and minimum thermometer, but without any observations after sunset. This is an improvement upon the former records, but falls short of the requisites for scientific purposes. The maximum and minimum thermometer certainly gives the range of temperature, but does not give the hours of the occurrence of the maxima and minima. Mean temperatures deduced from a maximum and minimum thermometer may possibly be true; but an arithmetical mean from two extreme observations daily would be incorrect, unless the increment and decrement of heat from a mean point were regular, which is known to be rarely the case. Annual mean temperatures deduced from formulæ, of which the latitude is the element, are often fallacious; for independently of the great discrepancies in mean temperatures between America and Europe on the same parallels of latitude, and as indicated also by isothermal lines in Europe, there are places differing little in longitude where the annual mean temperature is higher than at places nearer to the equator, both within and without the tropics: taking an instance from DOVE's temperature tables, we have the following:—

1	Aberdeen .	Latitude 57° 9′	Mean temperature 49°·18	
2	Dundee . .	Latitude 56 27	Mean temperature 51·94	
3	Edinburgh .	Latitude 55 58	Mean temperature 47·13	
4	Liverpool .	Latitude 53 25	Mean temperature 50·80	
5	London . .	Latitude 51 30	Mean temperature 50·83,	or 49·7 by GLAISHER.

Aberdeen, therefore, nearly six degrees north of London, has almost the same mean temperature as London: and Edinburgh, intermediate between both, has a lower mean temperature than either. Dundee, five degrees north of London, has absolutely a higher mean temperature; and Liverpool, two degrees north of London, has the same mean temperature. In the tropics similar instances are found.

Calcutta	Latitude	22° 34′ 40″	Mean temperature	83°·72
Bombay	Latitude	18 55 42	Mean temperature	81·1
Madras	Latitude	13 4 10	Mean temperature	82·42
Aden	Latitude	12 46 26	Mean temperature	80·2

In this case Calcutta, 9 degrees north of Madras and 3½ of Bombay, has a higher mean temperature than either; and Aden, in a lower latitude than any of the places,

instead of a higher has a lower mean temperature than Calcutta, Bombay or Madras. This mean temperature at Madras and Bombay is deduced from hourly observations; and had Dove's previously noticed mean temperature been derived from similar records, the anomalies might have been modified or have disappeared altogether. With the reservations contingent upon the explanations given, I shall comprise my observations upon the temperature tables of places other than those for Madras and Bombay, within very narrow limits. And first, with respect to Calcutta, the means are derived from observations taken at the Surveyor-General's office, with excellent instruments, but the observations are day observations, and it is only for the last six months of 1848 that records were made every two hours. The means, however, of those six months correspond sufficiently near with those of the same six months in the three preceding years to show that the conversion of three-hourly observations into two-hourly observations, had very little effect upon the mean results. What was wanting were observations at night, and of these there are not any. The mean temperature of the years, from 1845 to 1848, both inclusive, never falls below 83°·26 (in 1847), and was as high as 84°·11 in 1845, and the mean temperature of the four years is 83°·72. The coldest month was December, excepting in 1848, when January was the coldest. The hottest month was May, excepting in 1846, when April was the hottest; the mean temperature of April and May, for the four years, being respectively 87°·12 and 90°·27. For the years 1846 and 1847 the mean monthly increment to the maximum heat, and mean monthly decrement to the minimum heat, is gradual and regular, but in 1845 and 1847 there are instances of inversion; in 1845 March is hotter than April; September is hotter than August; in 1848 September is also hotter than August, instead of being cooler. This very high mean temperature of Calcutta is not of ready explanation, even after making an allowance for the want of night observations: situated on a broad river, in the midst of cultivated, well-wooded and moist plains, and within the influence of the sea; on the verge of the northern tropic, it might have been supposed that its position, in respect to latitude, would have affected its mean temperature. The sun is vertical at Calcutta in the first week in June and July, but Calcutta attains its maximum heat in May, while the sun is yet approaching, and the mean temperature is actually diminishing, while the sun is passing and repassing from the tropic, and while the heat ought to be accumulating from the lengthened days, as is shown in the following tabular statement:—

	Latitude N.	Longitude E.	Sun vertical.	Longest day.
	° ′ ″	° ′ ″		h m
Calcutta	22 34 40	88 28 15	June 5—July 7.	13 23
Bombay	18 55 42	72 54 24	May 15—July 28.	13 08
Madras	13 4 10	80 21 35	April 25—August 18.	12 46
Aden	12 46 26	45 15 0		

Admitting that the lengthened time for which the sun is nearly vertical over Calcutta might raise the mean temperature of May, June and July, there would be a corresponding diminution in the months of December, January and February, in the long nights, and the mean temperature of the year should not be raised by the

great heats of April and May; but such, nevertheless, would not appear to be the case, at least in the absence of night observations. It will be remarked also, that the return of the sun over Bombay in July does not prevent a reduction of three degrees in mean temperature; this however might be attributed to the rains commencing; but in its passage over Madras in August the continued mean monthly fall of the thermometer is not interrupted, although it will be recollected there is not any monsoon at Madras in August to correct the effect of the sun's passage. The slanting rays of the sun, within certain angles of incidence without the tropics, produce a heat of great intensity, even where the physical characters of the country do not lead us to expect such a result; for instance, on the banks of the broad Indus in Scinde the thermometer is known to rise in the shade to 110°—120° Fahr. Recently, at Peshawur, the following is the record of the thermometer in a house from the 7th to the 14th of May 1849:—

	Sunrise.	8 A.M.	Noon.	4 P.M.	9 P.M.	Latitude N.
Highest	75°	89°	102°	104°	86°	33° 59′
Lowest	67	84	96	98	78	

On the 16th of June, at 4 P.M., thermometer 109°; on the 25th of July, 109°; August 3rd, 4th and 13th, 104°; the extremes being 67° and 104°, the mean 87°, and the range 37°. A register for the whole month, by Dr. J. Malcolmson, gives the following facts; the maximum being 109° on the 6th in a tent, and 106° on the 24th and 31st in a house.

Register of the Thermometer at Peshawur for May 1849.

Fahrenheit Thermometer. In the shade in a house in the city.							
Date.	Sunrise.	Noon.	4 P.M.	Date.	Sunrise.	Noon.	4 P.M.
1	63°	79°	66°	17	70°	98°	104°
2	65	73	66	18	73	99	100
3	64	87	91	19	81	97	103
4	63	75	85	20	80	102	105
5	61	96	91	21	83	99	105
6	64	102	109	22	91	102	105
7	90	100	104	23	85	100	104
8	67	108	99	24	88	98	106
9	70	107	101	25	82	99	105
10	70	104	100	26	85	99	104
11	65	102	95	27	84	99	104
12	70	106	106	28	84	97	103
13	70	107	104	29	85	99	104
14	71	100	101	30	84	99	105
15	90	106	98	31	88	102	106
16	70	104	105				

Note by Dr. J. Malcolmson.—The register was kept in a house, and that may account for the maximum being no higher than 109°.

Heavy rain, with thunder, lightning and hail, for the first four days in the month. Winds generally westerly, and south-west. Severe dust-storms occasionally.

On the 22nd of May 1849, at Ferozepore, lat. 30° 53′, on the Sutlege river, the thermometer stood at 104° in a good house, the usual precautions being taken against the hot winds. Even in August, at Peshawur, with thunder-storms and heavy rain on the 7th, 9th, 15th, 16th, 17th, 20th and 29th, and with several light showers besides, the maximum was 104° at 4 P.M., the minimum at sunrise 81°, the midday maximum 101°, and with a *midnight* maximum of 100°, and yet the Report says, "The month had not however been characterized, as would be supposed by the indications of the thermometer, by any unusual degree of heat *over those which had just preceded it*. It even did not range so high as in May, June and July*."

Even at Alten, in Finmark in Norway, in latitude 69° 58′, where the mean annual temperature is between 35° and 36° FAHR., and where in 1846 the thermometer sunk to 14°·8 below zero; on the 27th of July 1847, at noon, the thermometer in the shade rose to 84°·7 FAHR. Capt. SCORESBY, in his Arctic Voyages, somewhere mentions, I think, that the rays of the sun were sufficiently powerful to melt the pitch on the sunny side of his vessel, while the air was at a freezing temperature on the shady side. But these intense heats of summer are compensated for by a depression of temperature when the sun is at the southern tropic and the mean annual temperature is not raised. The high mean temperature of Calcutta, therefore, would seem to be influenced by local causes, independently of the vertical or oblique action of the sun, or the length of time the sun is above the horizon. But the anomalies of mean temperature are not limited to Calcutta. Aden, situated in latitude 12° 46′ 26″ N., longitude 45° 15′ E., on the shores of Arabia,—shores dreaded for their supposed intolerable heat, has a mean temperature (80°·2) lower than that of Bombay, Madras or Calcutta, with a less range of the thermometer, with a maximum heat only of 89° in May and October, and a minimum of 68°·5 in January! and most singularly the mean temperature for *every month* in 1848 is lower than the temperature of the corresponding month at Calcutta, and, with the exception of November, December and January, lower than at Madras or Bombay. From the maximum mean monthly heat in April 1830, at Calcutta, the temperature gradually declined until the mean monthly minimum in December, excepting in September and October, when the curve was interrupted by a rise of 1°·5 in the former month, and of 2°·3 in the latter; after December the temperature gradually rose to its mean maximum.

* Dr. WALLIN of Helsingfors, the traveller in Arabia, has furnished me with a copy of his register of the thermometer, from which I learn that at Bagdad, lat. 33° 20′ N., long. 44° 24′ E., the thermometer in the shade of a house on the second story, with a N.W. aspect upon the banks of the Tigris, on the 19th of July 1848, at 2 P.M. stood at 122°·9 FAHR., wind W.N.W., on the 13th and 18th at 120°·2, and on seven other days in the month of July at 118°·4; and the *lowest* heat in the month at 2 P.M. was 101°·3 on the 2nd of July, wind N.W., clear.

Curves of Temperature at High Levels.

Proceeding from the sea-level to considerable altitudes, we find that the mean temperature at Poona, in 1830, at 1823 feet above the sea-level, was 80°·28, differing only six-tenths from the mean temperature of Bombay for 1844, and less than one degree of Fahr. from the mean temperature of 1843 at Bombay. A difference of level of 1823 feet therefore gave a difference of less than one degree of temperature.

The comparison of the temperatures of the three stations of Mahabuleshwur, Mercara in Coorg, and Uttray Mullay in Travancore, all at the height of 4500 feet above the sea-level, and differing little in longitude, but several degrees in latitude, affords some interesting facts. The latitude of Uttray Mallay is *about* 8° 00′ N., long. 76° 00′ E., Mercara, lat. 12° 30′, long. 73° 30′, Mahabuleshwur, lat. 17° 58′, long. 73° 29′. The mean temperature of Uttray Mullay, situated nearest to the equator, is *lower* by 3°·35 than the mean temperature of Mercara, and 2°·66 lower than that of Mahabuleshwur, while the mean temperatures of Mercara and Mahabuleshwur are almost identical. The maximum heat of Mahabuleshwur, in both years recorded, is in April, while the mean of three years at Mercara fixes it in March. At Uttray Mullay the maximum heat, in 1845, was in April, while in 1846 it was in March. At 4140 feet above these levels, namely, at Dodabetta, the maximum heat was, in May, as in Bombay and Calcutta. The minimum heat, at the height of 4500 feet, was in December, at Mahabuleshwur and Mercara in all the years. At Uttray Mullay, in 1845, the minimum mean monthly heat was in June, the only instance of the kind in all the observations discussed in this paper; and in this same year January and October had the same mean temperature. In the next year the minimum heat was in January. At Dodabetta, at 8640 feet, in 1847, the minimum temperature was in December, but, with the exceptions of April and May, the mean monthly range was so small that most of the months were nearly the same in their mean heat. Mahabuleshwur and Mercara being within the S.W. monsoon, while Uttray Mullay and Dodabetta are subject to both S.W. and N.E. monsoons, the annual curves of temperature might be expected to vary considerably. At Mahabuleshwur and Mercara there is a gradual decrement of heat from the maximum point until the month of October, when the mean monthly temperature rises at both places, but falls after that month to the minimum of the year. The same thing occurs in Bombay and Poona, but there is no rise in October at Madras nor at Calcutta in 1846 or 1847; and in 1845 and 1848, when the gradual decrement of heat was interrupted, it occurred in September instead of October, as at the other places within the influence of the same monsoon. At Uttray Mullay and Dodabetta, within the influence of both monsoons, we find the annual curve of temperature interrupted in the first place in March, then in July, October and November in 1845, and in July, August and September in 1846. At Dodabetta the increase is quite gradual from December to May; but the natural decrement is interrupted in July, and the temperature rises in August, sinks in September, rises in October, and then falls to the minimum of the year. From these facts, it appears that the two monsoons derange the

curves of temperature at the different places, which might be expected otherwise to coincide with the sun's path in the ecliptic; but further observations from the hill stations may modify these conclusions.

Range of Temperature and Hours of Maxima and Minima.

Unless where hourly observations are taken, the exact periods of the occurrence of the maxima and minima cannot be determined; and though a self-registering thermometer will determine the range of temperature, yet the hours of the turning-points cannot be learnt from it. For the hours of the occurrence of the maxima and minima, therefore, I am limited to the hourly observations taken at Madras and Bombay; but for the range of temperature, without reference to specific times, I can avail myself of a maximum thermometer registered at Aden for 1848, and one at Calcutta registered since June 1848.

Madras.—Hours of Maximum and Minimum Temperature.

The usual impression in India is, that the maximum heat occurs about 2 P.M., and the minimum a little after sunrise. The Madras hourly observations for four years, from which the following Table is prepared, exhibit great anomalies in the hours of the occurrence of the maxima and minima. In the forty-eight months of monthly range there are seventeen records of the greatest heat occurring about noon (between $11^h\ 41^m$ and $12^h\ 41^m$); eighteen records between 1 and 2 P.M., and thirteen records between 2 and 3 P.M. In 1842 the maximum daily heat occurred only *once* about noon ($12^h\ 41^m$) on the 20th of April ($96^\circ{\cdot}5$). In 1843 it occurred at the same hour, or before it, in January, February, March, May and November. In 1844, at the same hour, in January, April, November and December. In 1845, in March, April, May, September, October, November and December; so that in fact the maximum daily heat, although it took place only at noon in the month of April in 1842, in the other three years, either in one year or the other, occurred at noon in all the months. There is not a single instance of the maximum daily heat occurring after $2^h\ 41^m$ P.M. The minimum heat of the month, in 1842, occurred in May at $2^h\ 41^m$ A.M. ($81^\circ{\cdot}1$), the only record of the kind in the year. In 1843 there is no similar record, but in 1844 there are two instances of the least heat taking place in July and August at 41^m past midnight, and one instance at $2^h\ 41^m$ A.M. in September. In 1845 there is a solitary case of the lowest temperature at $2^h\ 41^m$ A.M. In the whole four years there are only three instances of the minimum heat being at $3^h\ 41^m$ A.M., two at $4^h\ 41^m$ A.M., twenty-five at $5^h\ 41^m$ A.M., and twelve at $6^h\ 41^m$ A.M.; and one singular instance of the greatest cold in the month being as late as $7^h\ 41^m$ A.M. on the 14th of May 1844. It may be affirmed, therefore, that the greatest cold occurs at Madras most often at $5^h\ 41^m$ A.M. The monthly range of the thermometer does not differ very much in the different months of the year, nor does the range of the

thermometer in the same months in successive years exhibit very marked discrepancies, although there are some differences; for instance, in February 1842 the range was 20°·8, and in February 1845 only 14°·2. In April 1842 the range was 22°·0, and in April 1843 only 14°·8. It might have been expected that the greatest range, as at Bombay and Calcutta, would have occurred in the coldest months, and that the greatest discrepancies would have occurred in the comparisons of the same months in succeeding years, but such was not the case. The greatest monthly range in any month at Madras, twice occurred in the month of May in 1844 and 1845, namely, 25°·9 and 25°·6 respectively. The least range, 12°·5, took place in January 1843. The annual ranges varied only from 27°·0 in 1843 to 37°·1 in 1844*. For Bombay I have only hourly readings of the thermometer for 1843 and 1844. The maximum heat twice occurred at noon, on the 11th of August and 6th of December; twice at 1 P.M., on 31st of March and 29th of April; five times at 2 P.M., and three times at 5 P.M. There is not any conformity in the times or dates of these maxima with those of the same year at Madras. A remarkable feature in the minimum daily heat at Bombay is the comparatively late period of the morning at which it took place. On the 4th of January the minimum heat was at 8 A.M., in five other months it occurred at 7 A.M., in two months at 6 A.M., and once only at 5 A.M.; and entirely unlike the numerous instances at Madras, there is not a single case of the minimum heat falling before 5 A.M. in 1843. The greatest range of the thermometer was in the cold months and least in the monsoon; the maximum, 19°·3, was in January, and the minimum, 8°·4, in August. The annual range for 1843 was 24°·4. In 1844 the chief feature is, that the minimum heat in the month occurred at midnight on the 28th of August, and the minimum temperature occurred at 1 and 2 A.M. on the 22nd of July, as well as at 5 A.M.; twice only the least heat occurred as late as 7 A.M.; the maximum heat never occurred after 3 or before 1 P.M. The maximum heat was 91°·9 and the minimum 64°·7, the annual range therefore 27°·2. The greatest monthly range was in February, 20°·7, and the least in August, 8°·5. The monthly ranges of the two years had a close correspondence. The maximum heat observed in the sun in Bombay was 142°·6 at 1 P.M., 10th of November 1846.

Calcutta Range of Temperature.

Hourly observations not having been taken at Calcutta, and the records of a maximum and minimum thermometer having only appeared in the Asiatic Journal since June 1848, I can only give the range of temperature since that date; but I know nothing of the days or hours of record, excepting what is derived from a foot-note at page 550 of the Number of the Journal for June 1848. As at Bombay, the greatest monthly range was in the cold months and least in the monsoon months. Two

* A memorandum just received gives the mean temperature of Madras for 1848 at 83°·15; the maximum on the 20th of June 106°, at 3^h 41^m P.M., and the minimum 63°·5 on January 26th, at 6^h 41^m A.M.; the annual range therefore was 42°·5.

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Range of Thermome

	Madras, 1842.							Madras, 1843.							Madras, 1844.					
	Minimum.			Maximum.				Minimum.			Maximum.				Minimum.			Maximum.		
	Therm.	Hour. A.M.	Date.	Therm.	Hour. P.M.	Date.	Range.	Therm.	Hour. A.M.	Date.	Therm.	Hour. P.M.	Date.	Range.	Therm.	Hour. A.M.	Date.	Therm.	Hour. P.M.	Date.
January	69°·5	h m 6 41	6	85°·1	h m 1 41	27	15°·6	70°·5	h m 5 41	5	83°·0	h m 0 41	4	12°·5	66°·2	h m 6 41	24	82°·8	h m 0 41	27
February......	67·2	5 41	17	88·0	2 41	28	20·8	69·2	6 41	9	85·4	0 41	19	16·2	67·7	5 41	19	87·2	1 41	26
March.........	72·4	6 41	10	92·0	1 41	20	19·6	74·1	3 41	16	89·8	0 41	26	15·7	72·0	6 41	10	90·7	1 41	25
April	74·5	5 41	1	96·5	0 41	20	22·0	78·5	4 41	9	93·3	1 41	30	14·8	77·2	5 41	8	99·0	0 41	3
May	81·1	2 41	1	100·8	2 41	31	19·7	76·2	5 41	23	93·8	A.M. 11 41	1	17·6	77·4	7 41	14	103·3	1 41	5
June	78·8	5 41	12	100·2	2 41	21	21·4	78·7	3 41	14	95·4	1 41	9	16·7	80·3	3 41	16	103·2	1 41	11
July	79·1	5 41	5	98·6	1 41	10	19·5	78·7	5 41	31	95·5	2 41	21	16·8	77·8	0 41	21	96·2	2 41	8
August	75·6	6 41	19	94·8	2 41	1	19·2	78·2	5 41	28	95·3	1 41	7	17·1	78·1	0 41	6	95·3	1 41	23
September ...	75·7	6 41	12	92·5	1 41	6	16·8	76·9	6 41	28	95·3	2 41	1	18·4	75·4	2 41	18	94·7	2 41	9
October	74·2	5 41	25	90·5	2 41	3	16·3	72·9	5 41	23	87·5	2 41	23	14·7	73·5	5 41	24	88·5	2 41	25
November ...	71·0	5 41	21	84·6	1 41	2	13·6	69·4	5 41	29	85·2	0 41	1	15·8	70·9	5 41	19	86·0	A.M. 11 41	8
December ...	68·5	6 41	12	82·8	1 41	25	14·3	68·0	5 41	31	82·5	1 41	8	14·5	69·6	6 41	3	83·5	0 41	2
Year	67·2	5 41	...	100·8	2 41	...	33·6	68·0	5 41	...	95·5	2 41	...	27·0	66·2	6 41	...	103·3	1 41	...

[Lieut.-Colonel SYKES's Discussion of the Meteorological Observations taken in India.]

ermometer and Hours of occasional Minima and Maxima.

.			Madras, 1845.							Bombay, 1843.							Bombay, 1844.						
aximum.			Minimum.			Maximum.				Minimum.			Maximum.				Minimum.			Maximum.			
our. M.	Date.	Range.	Therm.	Hour. A.M.	Date.	Therm.	Hour. P.M.	Date.	Range.	Therm.	Hour. A.M.	Date.	Therm.	Hour. P.M.	Date.	Range.	Therm.	Hour. A.M.	Date.	Therm.	Hour. P.M.	Date.	Rang
m		°	°	h m		°	h m		°	°	h		°	h		°	°	h		°	h		°
41	27	16·6	68·2	6 41	23	84·3	2 41	30	16·1	65·9	8	4	85·2	3	31	19·3	66·0	6	12	83·9	1	13	17
41	26	19·5	71·8	5 41	28	86·0	1 41	21	14·2	70·9	7	18	85·6	2	2	14·7	64·7	7	9	85·4	3	14	20
41	25	18·7	73·6	5 41	7	92·3	0 41	30	18·7	73·0	7	2	88·2	1	31	15·2	70·4	6	3	87·0	1	29	16
41	3	21·8	78·5	6 41	30	94·0	0 41	11	15·5	79·0	6	3	90·0	1	29	11·0	77·3	6	2	90·2	2	21	12
41	5	25·9	78·8	4 41	6	104·4	0 41	12	25·6	80·9	6	4	90·3	2	1	9·4	81·9	5	10	91·9	2	27	10
41	11	22·9	78·8	2 41	18	101·0	1 41	6	22·2	80·5	6	19	90·0	2	10	9·5	78·0	4	30	90·8	2	13	12
41	8	18·4	79·3	5 41	20	97·7	2 41	10	18·4	78·3	7	15	88·1	2	1	9·8	78·0	5	22	87·2	2	2	9
41	23	17·2	79·0	5 41	19	97·1	1 41	28	18·0	77·5	7	22	85·9	12*	11	8·4	77·0	Midnight	28	85·5	2	26	8
41	9	19·3	76·2	5 41	16	94·8	0 41	2	18·6	76·4	6	29	87·6	2	23	11·2	75·4	4	14	86·1	3	29	10
41	25	15·0	75·3	5 41	27	91·5	0 41	3	16·2	77·0	5	24	87·8	3	21	10·8	75·3	5	28	90·5	1	4	15
.M. 41	8	15·1	70·3	5 41	26	88·2	A.M. 11 41	6	17·9	76·5	6	30	88·0	3	6	16·5	73·9	6	21	90·9	2	3	19
41	2	13·9	70·0	5 41	18	83·5	11 41	10	13·5	68·4	7	20	85·9	12*	6	17·5	69·8	7	9	87·8	1	19	18
41	...	37·1	68·2	6 41	...	104·4	0 41	...	36·2	65·9	8	...	90·3	2	...	24·4	64·7	7	...	91·9	2	...	27

* Noon.

ximum.		Aden, 1848.			Calcutta, 1848–49.			
Date.	Range.	Min.	Max.	Range.	Min.	Max.	Range.	
13	17·9	68·5	76·7	8·2	57·5	78·5	21·0	January.
14	20·7	69·0	77·8	8·8	64·6	83·5	19·9	February.
29	16·6	71·6	82·0	10·4	72·0	93·7	21·5	March.
21	12·9	75·5	85·8	10·3	79·4	99·4	20·0	April.
27	10·0	80·6	89·0	8·4	79·6	97·8	18·2	May.
13	12·8	82·5	88·5	6·0	81·1	92·8	11·7	June.
2	9·2	80·4	86·4	6·0	81·4	91·8	10·4	July.
26	8·5	78·4	84·6	6·2	80·8	90·2	9·4	August.
29	10·7	81·6	88·2	6·6	80·7	92·4	11·7	September.
4	15·2	77·8	89·0	11·2	75·8	89·1	14·3	October.
3	19·0	73·7	83·1	9·4	68·3	84·9	16·6	November.
19	18·0	75·0	81·6	6·6	68·8	82·4	18·6	December.
...	27·2	68·5	89·0	20·5	57·5	99·4	41·9	Year.

maxima ranges of 21°·5 and 21° occur in March and January, and the minimum, 9°·4, was in August. The annual range was nearly double that of Bombay, namely, 41°·9. The foot-note above alluded to has the following records:—

1846.	Maximum heat in May	105°·0
1846.	Minimum heat in January	55·0
1847.	Maximum heat in May	109·6
1847.	Minimum heat in February	50·0

The range in these two years, therefore, being respectively 50° and 59°·6 Fahr.; the thermometer rising higher and sinking lower than either at Madras, Bombay or Aden near the sea-level.

Range of Temperature at Aden.

Extending the comparison of thermometric range near the sea-level to Aden, in the latitude of Madras, but 35°·6 to the westward of Madras, it will be seen that, unlike Bombay or Calcutta, the greatest range is not in the cold months, nor in the months in which the maximum heat occurs, but in those months in which the mean temperature is comparatively moderate, viz. March, April and October; the smallest range however occurring, as at Calcutta and Bombay, in what are called the monsoon months at those places, namely, May, June, July, August and September, while in those months at Madras the greatest range of the thermometer takes place. The greatest monthly range at Aden, 11°·2, occurs in October, and the least monthly range, 6°·0, is almost identical in the consecutive months of June, July, August and September. The annual range is 20°·5. If the records of 1848 exhibit normal con ditions, then the climate of the dreaded Aden is more equable than that of places on the sea-level on the coasts of India.

The annexed Table contains the elements of the preceding notices:—

Range of Temperature at High Levels.

With respect to the majority of the stations at different elevations above the sea, as hourly observations were not kept, and a maximum and minimum thermometer only used, at Mahabuleshwur and Dodabetta the *hours* of the occurrence of maxima and minima cannot be stated.

Sattarah.—Range of Thermometer.

At Sattarah, the results of four years' observations by Dr. MURRAY, from 1844 to 1847 inclusive, are as follows:—

	Minimum temperature.	Maximum temperature.	Maximum daily range.	Maximum monthly range.
January	53·0°	86·0°	23·0°	31·0°
February	50·5	90·0	26·0	33·0
March...............	62·0	100·0	32·0	38·5
April	64·0	102·0	31·5	36·5
May	70·0	103·0	26·0	29·5
June	69·0	93·0	22·0	22·0
July	60·0	91·0	7·5	11·0
August	60·0	80·0	10·0	10·0
September	64·0	83·0	16·0	19·0
October	63·0	93·0	21·0	30·0
November	58·0	85·0	21·0	25·0
December	57·0	86·0	25·0	27·0
Year	50·5	103·0	32·0	38·5

The minima and maxima in temperature represent the highest and lowest state of the thermometer ever indicated in January in four years, and the same for the other months; and the maxima and minima are not necessarily in the same year. The ranges represent the greatest and least in any particular day or month.

The maximum temperature, at 2320 feet, exceeded that recorded in Bombay, and the daily and monthly range were greater, but considerably less than at Mahabuleshwur at 4500 feet. In four years at Sattarah the extreme range of the thermometer was 52°·5, from 50°·5 to 103°·0, while at Mahabuleshwur in fifteen years the range was only 47°·0. The minimum temperature does not appear to have been below 50°·5, while I have observed it about the latitude of Sattarah, and at 400 feet lower level, at 40°·5 in January; and at 3123 feet in May I had it rise, at 3½ P.M., to 105°.

The following is extracted from a synopsis of fifteen years' observations at Mahabuleshwur, from January 1829 to December 1843, from observations successively taken by Doctors WALKER, MOREHEAD and MURRAY:—

Extreme daily range.	Extreme monthly range.	Extreme depression at night, thermometer exposed.	Months.	Maximum temperature.	Minimum temperature.	Range in fifteen years.
21·0°	30·5°	30·0°	January	79·5°	45·0°	34·5°
23·8	32·1	31·5	February	85·5	46·0	39·5
23·5	38·0	33·0	March	89·0	49·5	40·5
22·0	34·5	36·5	April	92·0	56·0	36·0
22·0	32·0	30·2	May..................	90·0	57·3	32·7
18·5	25·5	......	June..................	84·0	53·0	31·0
12·7	18·5	......	July	73·8	51·5	22·3
11·1	13·0	......	August...............	70·8	53·0	17·8
14·0	17·0	......	September	77·0	56·0	21·0
17·5	23·0	34·1	October	78·5	54·0	24·5
16·5	23·0	29·5	November	75·0	51·5	23·5
19·0	27·5	27·5	December	76·0	48·5	28·5
23·8	38·0	27·5	Year.................	92·0	45·0	47·0

Mahabuleshwur.—Range of Thermometer.

The range of the thermometer in fifteen years was 47° Fahr., from 92° in April to 45° in January, but it will be seen that the thermometer exposed to radiation at night had been as low as 27°·5, and in every month of the year, excepting the four monsoon months, verged upon the freezing-point; the maximum heat in the sun was 110° in April and May, at 9 a.m., but at midday it had risen to 127°. The extreme daily range never exceeded 23°·8, and the maximum monthly range was 38° Fahr. The record of the night thermometer at Mahabuleshwur giving instances of the temperature in five months of the year sinking below the freezing-point, although it is not described as being placed on the grass or ground, affords an explanation of an otherwise puzzling record in the Dodabetta observations, namely, "on the 15th, 16th, 17th and 22nd of November 1847, found ice around the office" (at sunrise?), although there is not any record of the thermometer below 45°·2 on the 16th at Dodabetta, and in the *hourly* observations of the 22nd the thermometer only once sank to 48°·6 at 11 o'clock at night; the extreme cold, therefore, must have been caused by radiation and evaporation*. An old officer, who had often resided at Mahabuleshwur, tells me that he has frequently witnessed hoar-frost on the ground at Mahabuleshwur, though he had never *remarked* the thermometer sinking below 45°. The highest temperature in the sun at Mahabuleshwur was 127° in March and May.

Dodabetta.—Range of Thermometer.

At Dodabetta the following are the maxima, minima and ranges:—

	Minimum temperature.	Maximum temperature.	Maximum daily range.	Maximum monthly range.
1847.				
February	41·2 °	61·0 °	12·0 °	19·8 °
March	43·5	67·0	15·5	23·5
April	47·0	66·5	16·7	19·5
May	46·0	65·8	15·3	19·8
June	44·0	60·0	11·8	16·0
July	44·3	59·0	13·9	14·7
August	44·5	59·1	14·1	14·6
September	41·8	59·0	10·6	17·2
October	42·8	58·8	10·3	16·0
November	42·9	61·1	13·1	18·2
December	41·0	60·4	15·5	19·4
1848.				
January	38·5	62·8	19·5	24·3
Year	38·5	67	19·5	28·5†

Hence it is seen that the Dodabetta temperature, at 8642 feet, compared with that of Mahabuleshwur at 4500 feet, has a decidedly diminished daily, monthly and annual range. It so happens that the lowest but not the highest state of the thermo-

* There is not any record of the radiation thermometer in November at Dodabetta, but in February it appears to have been twice below the freezing-point.

† Annual range.

meter, and the greatest daily and monthly range, occur in the same month at Dodabetta, namely, January 1848. The lowest temperature in the year was 38°·5, the highest 67°, and the annual range 28°·5. The greatest monthly range was 24°·3.

Aqueous Vapour.

Preliminary to the discussion of the question of aqueous vapour, a few words are necessary on the caution requisite in generalizing on a limited number of facts, or on observations not extending over lengthened periods of time. The hourly observations of the wet bulb at Madras and Bombay, for 1843 and 1844, are apparently trustworthy and satisfactory, supposing the wet bulb theorem to be correct. Those at Calcutta were taken only twice daily, at 9^h 40^m A.M. and 4 P.M., and how far observations, taken twice only during the daytime, can be relied upon for the expression of normal conditions, will best be shown by the following comparison of observations of the wet bulb at Dodabetta at 8640 feet above the sea-level. The regular meteorological observations were recorded twice a day only, at 9^h 40^m A.M. and 3^h 40^m P.M., but on one day in each month independent observations were taken for twenty-four consecutive hours. In a table I have compared the means of the 9^h 40^m A.M. and 3^h 40^m P.M. observations with the means of the twenty-four consecutive hours for the same day. The discrepancies are considerable, and too numerous to admit of the supposition of their resulting from accident or carelessness. On the 21st and 22nd of January the hourly observations give a depression of the wet bulb of 9°·2. The twice a day observations give a depression of 9°·4; on the 21st and 22nd of March a depression respectively of 5°·7 and 7°·7; on the 21st and 22nd of April of 5°·2 and 4°·2; on the 21st and 22nd of May of 1°·8 and 1°·33; and on the 21st and 22nd of November of 7°·8 and 6°·1. A bare inspection of the several hygrometric records for Dodabetta will show the anomalous results in working out the dew-points, elastic force of vapour, and per-centage of vapour or fraction of saturation in the atmosphere by the tables founded on Dr. APJOHN's formula. The hourly observations also demonstrate, that on the same day, in a transient fog without rain, there shall not be any depression whatever of the wet bulb; while in the course of the twenty-four hours there may be a great depression. For instance, at noon, on the 21st of December 1847, there was not any depression, but at 9 the next morning there was a depression of 3°·2, the mean being 1°·6, while the mean of the twenty-four hours was 0°·7. At the former hour there was a fog, at the latter, partly a blue sky. Again, at 5 P.M., on the 21st of November, the depression was 1°·5, but at 8 P.M. the depression was 10°·9, the mean being 6°·2, the mean of the twenty-four hours 7°·8; in both cases there was nearly a blue sky. At noon, on the 21st of July, there was not any depression in a fog; at 5 A.M. of the 22nd a depression of 2°·0, and *yet it was raining*. On the 21st of April, at 8 P.M., the depression was nil, an hour after it was 5°·5; at both hours with nearly a blue sky, while at 7 A.M. of the 22nd the depression was 9°·5, with a cloudy sky. Supposing these to have been the only observations available for the respective days,

could any of them or their means have been safely taken to express normal conditions? Professor ORLEBAR, in his Meteorological Observations at Bombay for 1846, gives proofs of the necessity for caution in the use of the wet bulb: in the first place, he was obliged to abandon the records of the air-thermometer attached to the wet bulb from the irregular depression of the former, by the cold of the evaporating surface of the latter; and in the next place, on the comparison of the action of two wet bulbs, one inside the observatory and the other outside, he records discrepancies in March ranging from 3°·2 plus to 2°·6 minus; the comparisons in April and May exhibited minor discrepancies, excepting on the 27th of April at the 18th hour, when the discrepancy was 3° minus. Professor ORLEBAR having used DANIELL's hygrometer simultaneously with the wet bulb for eight months in 1846, the means of comparison are afforded, and the following Table exhibits the results. I have taken the two daily observations at $9^h\ 12^m$ A.M. and $3^h\ 12^m$ P.M. on the first day of each month for the comparison.

Dates.				Thermometers.		Dew-point by		Tension of vapour by		Fraction of saturation or per-centage of moisture in the air by	
Months.	Day.	Local hours.	Barometer.	Dry.	Wet.	Wet bulb.	DANIELL's hygrometer.	Wet bulb.	DANIELL's hygrometer.	Wet bulb.	DANIELL's hygrometer.
		h m	in.	°	°	°	°				
January	1st	9 12	30·092	79·	72·8	70	66·8	0·726	0·655	75	67½
		3 12	29·942	83·5	73·3	68·6	69·9	0·695	0·724	62	64¾
February ...	1st	9 12	29·987	76·3	71·6	69·4	73·0	0·713	0·801	80	90
		3 12	29·879	80·4	72·0	68·05	71·0	0·682	0·751	67	74
March.........	1st	9 12	30·003	79·6	73·5	70·8	75·1	0·746	0·856	75½	86¾
		3 12	29·878	83·3	75·6	72·35	75·5	0·785	0·867	70	78
April	1st	9 12	29·899	84·4	75·4	71·6	73·5	0·765	0·814	66½	70¾
		3 12	29·804	87·6	74·2	68·15	73·1	0·684	0·803	54	63¼
May	1st	9 12	29·834	92·5	80·8	76·55	80·8	0·897	1·027	60¾	69
		3 12	29·731	96·8	80·5	74·4	76·9	0·838	0·907	50	54
June	1st	9 12	29·748	83·2	80·8	80·0	81·5	1·000	1·049	90	94¾
		3 12	29·668	90·7	84·4	82·45	81·5	1·081	1·049	78	75
July	1st	9 12	29·615	81·4	80·0	79·2	78·5	0·976	0·955	90	88½
		3 12	29·585	81·8	79·0	78·0	78·8	0·939	0·964	88¾	91½
August	2nd	9 12	29·728	81·2	79·9	79·45	78·6	0·984	0·958	94¾	92
		3 12	29·678	84·4	81·0	79·85	77·5	0·996	0·925	86¾	80½
September ...	1st	9 12	29·735	84·0	80·0	78·6	77·5	0·957	0·925	84½	81½
		3 12	29·666	83·8	80·0	78·7	76·3	0·959	0·890	85	79

These observations having been made by the instructed and practiced manipulators of the Bombay Observatory, claim to be worthy of confidence; but we find ourselves in doubt which of the two sets to use for the correction of the barometer and to determine the real amount of moisture in the atmosphere. It would appear, that when the depression of the wet bulb and of DANIELL's hygrometer is small in the monsoon months, their results do not differ very widely, the wet bulb however giving a higher tension of vapour and greater per-centage of moisture or fraction of saturation in the atmosphere than DANIELL's hygrometer; but in the cold and hot months of the year

this is reversed; considerable discrepancies occur in the results, and the tension of vapour is much higher (with one exception) and the per-centage of moisture much greater by DANIELL's hygrometer than by the wet bulb, the dew-point by the two instruments differing from 3° to 5°. On the 1st of February, in the morning, the two instruments differ ten per cent. in the amount of moisture in the atmosphere. In the afternoon they differ seven per cent., in both instances DANIELL's hygrometer giving the greatest amount. On August the 2nd and September the 1st, in the afternoon, the instruments differ above six per cent., but at this period of the year the wet bulb gives the greatest amount of moisture in the atmosphere and DANIELL's hygrometer the least. The greatest depression of the dew-point in the above observations was 22°·4 on the 1st of May at 3^h 12^m P.M. In a former paper in the Philosophical Transactions I mentioned a depression of 40°, from 67° to 27°, on the 13th of March 1828 at sunrise in the Hill Fort of Loghur, and of 61° on the 16th of February 1828 at 4 P.M. at Downde near Pairgaum on the Beema river.

I have put into juxtaposition with this table a comparison of the results of hourly observations at Dodabetta of the wet bulb, with the two regular observations made on the same day. In November the simultaneous dew-points by the two processes are 36°·1 and 42°·15; in January 30°·7 and 33°·2; in March 43°·3 and 39°·6, and in April 42°·2 and 40°·95. Whether therefore there be 59½ or 69 per cent. of moisture in the atmosphere in November; 71 or 61½ per cent. in March; or 73° or 78½ per cent. in April, nothing short of continued hourly observations, like those at Madras and Bombay, will enable the meteorologist to determine.

Dodabetta.—Simultaneous observations, 8640 feet, on the 21st and 22nd of each month.

	Depression of the wet bulb by			
	Hourly observations.	Twice a day, ditto.	Dew-point by hourly.	Dew-point by twice a day.
January	9·2	9·4	30·7	33·2
February	1·4	0·9	49·7	50·3
March	5·7	7·7	43·3	39·6
April	5·2	4·2	42·2	40·95
May	1·8	1·33	54·2	55·8
June	0·5	0·2	51·2	51·75
July	0·8	0·23	53·15	53·75
August	0·5	0·37	54·35	55·43
September	0·4	0·6	52·95	53·1
October	0·7	0·4	53·1	52·9
November	7·8	6·1	36·1	42·15
December	0·7	0·95	50·65	50·65

Any such high per-centage of moisture however was not the case on the plains of the Deccan, where the dew-point was determined by DANIELL's hygrometer.

The natives of the Deccan divide the year into three seasons—the Hewalla (cold), Oonalla (hot), and Pawsalla (wet) seasons; the per-centage of vapour was in the

Cold months, Nov., Decem., Jan., Feb. . . . . 46½ per cent. of moisture.
Hot months, March, April and May . . . . 42½ per cent. of moisture.
Wet or monsoon months, June, July, Aug., Sept., Oct. . . 77·4 per cent. of moisture.

But another uncertainty is the numerical value to be given to the wet bulb readings, whether by APJOHN's formula or by the means of factors, which Mr. GLAISHER of the Royal Observatory has adopted from a comparison of observations between the wet bulb and DANIELL's hygrometer. Dr. MURRAY, in charge of the Sanatarium at Mahabuleshwur, at 4500 feet, observed with the wet bulb for nine years, and has given the mean monthly depression of the wet bulb for that period in the Journal of the Physical Society of Bombay. He does not give any details of the character of his instruments, or with what precautions he used them, and as from 250 to 300 inches of rain fall at Mahabuleshwur in the S.W. monsoon months, it might have been expected that the air would have been much nearer to a state of saturation in those months than appears to be the case at Dodabetta in the same months, in which only 29 to 30 inches of rain fall. Subjecting these observations to the two methods, it is seen that the results go very well together with small depressions of the wet bulb and at temperatures ranging from 65° to 75°, but with depressions above 10° they immediately diverge, and the divergence would increase with greater depressions and at lower temperatures of the air.

Mahabuleshwur.—Nine years' Means of the Wet Bulb.

	Dry.	Depression.	Dew-point by GLAISHER.	Dew-point by APJOHN.	Tension by GLAISHER.	Tension by APJOHN.	Per-centage moisture by GLAISHER.	Per-centage moisture by APJOHN.
January	69·2	9·8	54·5	53·35	·435	·418	61·4	59·0
February	69·6	13·0	50·1	47·4	·376	·341	32·3	47·5
March	75·3	15·7	51·75	49·35	·396	·365	45·9	42·3
April	78·1	15·4	55·0	53·8	·442	·424	46·9	44·9
May	76·4	9·5	62·15	62·4	·562	·566	62·9	63·3
June	70·7	2·6	66·8	67·0	·655	·658	88·1	88·5
July	68·8	1·8	66·1	66·2	·640	·641	91·5	91·6
August	67·4	1·7	64·68	64·95	·611	·615	91·4	92·0
September	67·9	2·7	63·58	63·95	·589	·596	86·7	87·7
October	68·2	6·4	57·96	58·25	·489	·493	71·4	71·9
November	67·3	7·7	54·98	54·95	·442	·442	66·4	66·4
December	66·9	7·8	54·42	54·35	·434	·432	66·0	65·7
Fifteen years ...	70·4	7·84	58·64	58·25	·500	·493	67·9	66·9

Bearing therefore these discrepancies in mind, it may be justifiable to generalize so far only as to assert that two or three (or even four) observations with any meteorological instrument within the twenty-four hours, even under favourable circumstances, can do little more than give approximations to the truth; and that hourly observations, extending through four or five years at least, can alone satisfy the scientific

meteorologist, to enable him to determine the normal or abnormal atmospheric phenomena of the *locality* in which the observations are taken; and he will distrust the applicability of these *local* determinations to any other places situated beyond a certain circumscribed area.

With these remarks I proceed to consider the hygrometric features of certain widely separated stations in India, both at the sea-level and elevated at 1800 and 4500 and 8640 feet above the sea. The most marked feature is the singularly small monthly mean depression of the wet bulb, the high figures of the elastic force of vapour, and the great per-centage of moisture in the atmosphere; not only at the sea-levels of Madras, Bombay, Aden and Calcutta, but at Dodabetta, at 8640 feet above the sea, whether during the monsoons or during the cold and hot months, which are generally supposed to be the dry portion of the year, and the annexed Table exhibits the results.

At neither of the Presidencies is there a mean monthly per-centage of vapour at Madras below 67, at Bombay below 66, at Calcutta below 63, and at Dodabetta below 51, while the maximum at Dodabetta goes up to 98, and at Calcutta to 94; at Bombay it did not exceed 88, and at Madras, in two years, it only twice attained a mean maximum of 83 per cent. of moisture in the atmosphere. The mean annual per-centage of moisture in the air, it will be seen for the years 1843 and 1844, was at Madras respectively 75 and 74½, at Bombay 76 and 76, at Calcutta 80 and 84, at Aden 71, at Mahabuleshwur 67°·9, and at Dodabetta, for 1847–48, it was 90°. In the Deccan, in 1827, only 55°, as determined by DANIELL's hygrometer. The difference between the annual mean temperature of the air and the annual mean temperature of the dew-point, was—

Madras.		Bombay.		Calcutta.		Dodabetta.	Deccan.	Aden.	Mahabuleshwur.
1843.	1844.	1843.	1844.	1843.	1844.	1847–48.	1827.	1848.	Means of 9 years.
9°	9°·24	8°·65	8°·65	6°·95	5°·3	3°·1	17°·9	7°·5	12°·2

The air at Madras, Bombay and Calcutta, is unquestionably more moist than that of the interior; but the feeling and experience so little lead one to expect the high dew-points indicated, particularly in the cold and hot months, that some inaccuracy of observation or fallacy in deduction might be feared, were not the ability and zeal of the observers at Madras and Bombay, combined with the observations being hourly, a sufficient guarantee against error. At Calcutta, however, situated sixty miles from the sea, the hygrometric observations make the air much more moist even than at Madras and Bombay. This is contrary to probability, and may be owing to the means of the observations, made only twice a day, not giving the real mean of the twenty-four hours. At the peak or ridges of Dodabetta the air would appear to be nearly in a constant state of saturation; and there is a possibility in the circumstance, considering that it is the highest eminence in the peninsula of India and might be expected

Months.	Madras.								Bombay.								C			
	1843.				1844.				1843.				1844.				1843.			
	Thermometer, dry.	Thermometer, wet.	Elastic force.	Per-centage of vapour.	Thermometer, dry.	Thermometer, wet.	Elastic force.	Per-centage of vapour.	Thermometer, dry.	Thermometer, wet.	Elastic force.	Per-centage of vapour.	Thermometer, dry.	Thermometer, wet.	Elastic force.	Per-centage of vapour.	Thermometer, dry.	Thermometer, wet.	Elastic force.	Per-centage of vapour.
January	77°·59	72°·32	·726	79	75°·71	69°·57	·651	75	76°·3	68°·0	·598	69	75°·4	67°·5	·581	67	74°·9	68°·9	·674	79
February ...	77·90	71·86	·705	76	77·74	71·45	·694	75	78·0	70·7	·645	68	73·3	68·6	·608	68	81·4	71·8	·663	63
March	81·52	75·22	·791	76	82·20	75·51	·796	75	79·7	73·0	·726	73	79·5	73·4	·743	75	86·9	79·9	·920	74
April	85·19	78·93	·899	77	86·34	79·73	·921	76	84·2	77·9	·867	76	84·1	78·1	·876	77	91·3	83·2	·918	64
May	85·02	79·06	·908	78	86·98	79·98	·925	75	85·9	79·8	·927	77	85·9	78·8	·885	73	91·2	84·2	1·066	75
June	85·52	78·05	·860	73	88·58	78·82	·859	67	85·3	80·0	·943	79	85·3	79·9	·938	79	89·0	84·3	1·085	79
July	85·79	76·73	·803	67	85·76	77·86	·850	72	82·0	78·4	·912	85	81·9	79·0	·938	88	87·0	82·9	1·052	84
August	84·51	76·95	·826	72	85·25	77·94	·858	73	81·2	77·2	·872	84	81·6	78·0	·900	85	86·6	82·6	1·043	85
September ...	84·26	77·21	·839	74	82·97	77·37	·861	79	81·1	77·3	·876	84	80·7	77·0	·869	86	86·7	82·7	1·046	85
October	80·72	76·50	·851	83	80·53	75·86	·828	82	82·2	76·5	·832	77	83·5	78·0	·879	79	86·4	80·6	·956	78
November ...	77·83	71·71	·702	76	79·17	72·41	·713	73	80·3	72·2	·690	68	80·8	72·1	·681	66	80·3	74·4	·772	76
December ...	75·89	70·73	·691	79	76·94	72·90	·755	83	76·7	68·6	·603	67	79·6	71·6	·676	68	74·3	69·1	·762	94
	81·81	75·44	·796	75	82·34	75·78	·803	74½	81·1	75·0	·736	76	81·2	75·1	·789	76	83·8	78·7	·905	80

[Lieut.-Colonel Sykes's Discussion of Meteorological Observations taken in India.]

Calcutta.						Aden, 187 feet.				Deccan, mean height 1800 feet.				Mahabuleshwur, 4500 feet.				Dodabetta, 8640 feet.				
3.		1844.				1848.				Sunrise 9 to 10 A.M. and 4 to 5 P.M. 1827.				Means of 9 years, 1835 to 1843 inclusive.				1847 to 1848. Monthly means.				Ho 22
Elastic force.	Per-centage of vapour.	Thermometer, dry.	Thermometer, wet.	Elastic force.	Per-centage of vapour.	Thermometer, dry.	Thermometer, wet.	Elastic force.	Per-centage of vapour.	Thermometer.	DANIELL'S hygrometer.	Elastic force.	Per-centage of vapour.	Thermometer, dry.	Thermometer, wet.	Elastic force.	Per-centage of vapour.	Thermometer, dry.	Thermometer, wet.	Elastic force.	Per-centage of vapour.	Thermometer
·674	79	74°·1	68°·7	·636	76	74°·9	68°·9	·634	74½	72°·53	50°·31	·377	47	69°·2	59°·4	·435	61·4	52°·1	46°·15	·277	69	49°
·663	63	79·3	72·8	·723	73	75·6	69·4	·643	74	75·19	44·39	·308	36	69·6	56·6	·375	52·3	52·3	50·8	·379	93	52
·920	74	88·4	81·3	·965	74	78·4	72·9	·737	77½	74·73	48·83	·358	42	75·3	59·6	·396	45·9	53·0	48·8	·323	78	53
·918	64	91·5	84·9	1·095	76	81·3	75·4	·800	76¾	87·22	55·34	·447	36	78·1	62·7	·442	46·9	56·4	53·35	·393	84	52
·066	75	89·0	85·7	1·161	87	86·7	79·4	·902	73	84·75	64·54	·608	52	76·4	66·9	·561	62·9	57·2	54·95	·423	88	57
·085	79	87·9	85·1	1·144	90	87·4	79·4	·895	71	79·99	72·48	·788	84	70·7	68·1	·655	88·1	52·5	51·8	·391	96	52
·052	84	85·1	83·7	1·109	93	86·5	77·8	·839	68¼	77·03	71·69	·768	84	68·8	67·0	·640	91·5	52·60	52·15	·398	97	54
·043	85	84·6	83·3	1·096	94	85·5	76·0	·778	65½	76·21	71·03	·751	84	67·4	65·7	·611	91·4	53·10	52·5	·401	96	55
·046	85	86·4	84·3	1·123	92	86·1	78·0	·851	70¼	77·24	71·11	·753	82	67·9	65·2	·589	86·7	52·45	51·75	·390	96	53
·956	78	84·6	82·8	1·073	93	83·2	75·7	·790	71¼	77·71	58·68	·501	53	68·2	65·8	·489	71·4	53·30	52·8	·406	97	54
·772	76	82·1	78·9	·931	87	81·7	71·3	·642	60¾	75·46	55·54	·451	54	67·3	59·6	·442	66·0	52·15	50·95	·378	94	51
·762	94	75·9	71·8	·724	82	76·8	69·8	·644	71¼	72·59	51·31	·390	49	66·9	59·1	·434	66·0	50·80	48·75	·341	86	51
·905	80	84·07	80·25	·961	84	82·0	74·5	·758	71	77·55	59·60	·516	55	70·4	62·56	·500	66·9	53·16	51·2	·373	90	53

…feet.	Dodabetta, 8640 feet.				Month.
…s.	Hourly observations, 21st to 22nd. Monthly, 1847–48.				
Per-centage of vapour.	Thermometer, dry.	Thermometer, wet.	Elastic force.	Per-centage of vapour.	
69	49°·5	40°·3	·190	51½	January.
93	52·0	50·6	·369	91	February.
78	53·3	47·6	·296	71	March.
84	52·4	47·2	·296	78	April.
88	57·9	56·1	·444	91¼	May.
96	52·0	51·5	·389	97	June.
97	54·4	53·6	·415	96	July.
96	55·1	54·6	·432	97	August.
96	53·6	53·2	·413	98	September.
97	54·2	53·5	·415	96	October.
94	51·0	43·2	·230	59½	November.
86	51·8	51·1	·382	96	December.
90	53·02	50·13	·352	87	Year.

to attract much vapour, nevertheless the greatest quantity of rain does not fall at Dodabetta. The mean of the hourly observations once a month, and the mean of the two observations daily throughout the year, giving respectively 87 per cent. and 90 per cent. of moisture in the air at Dodabetta, observation and expectation thus go pretty well together, and the records might be satisfactory, were there not doubts about the manipulations with the wet bulb. The hygrometric observations in the Deccan with DANIELL's hygrometer, which were taken by myself thrice daily, are quite in accord with the feelings and with the expectations of the observer, excepting for the month of March, in which the feelings indicate the air to be quite as dry as in the months of February or April, but which the hygrometer indicates to be 6 per cent. nearer to saturation than in either February or April. At Aden, in the latitude of Madras, on the arid coast of Arabia, where little rain falls, the mean monthly and annual per-centage of moisture appears unexpectedly high; the lowest per-centage ($60\frac{3}{4}$) is in November, and the next lowest $68\frac{1}{2}$ and $65\frac{1}{2}$ respectively in August and September. The maximum per-centage was $77\frac{1}{2}$ in March, and the mean for the year 71. These results have a certain relation to the phenomena at Madras, which is destitute of a S.W. monsoon. The mean maximum tension of vapour was ·902 in May at Aden.

The mean monthly and annual results at the several stations have no doubt a certain relation to truth, as it is seen that the per-centages of moisture or fractions of saturation in the atmosphere in the different months of the year have an increasing or diminishing amount as the several months approximate to, or recede from, the monsoon months of the year; this is sufficiently shown at Madras, where the monsoon months are the dry months at Bombay and in the Deccan. Nevertheless the amount of moisture in the atmosphere, deduced from the observations of the wet bulb, is so very great compared with the amount determined by the direct method by DANIELL's hygrometer (itself an imperfect instrument) in the Deccan, and at some of the stations is so little in accord with personal recollections and experience, that I cannot refrain from suspecting some error of observation, some mismanagement in the manipulations, or a fallacy in the formula by which the dew-point is deduced from the temperature of the wet bulb. The first cause of error that struck me was that arising from the proximity of the dry to the wet bulb, as noticed by Professor ORLEBAR in his Report of Meteorological Observations taken at the Bombay Observatory in 1846. He had a stand erected out of doors, 6 feet high, and with a thatched roof, and every precaution was taken to guard off radiation by layers of cotton and tow upon a board under the roof upon which the meteorologic instruments were placed; there was lateral access for the air all round. He soon found that the dry bulb, in the neighbourhood of the wet bulb, was almost always depressed below the neighbouring *standard* thermometer, and that the depression of the *dry* bulb was greater as the depression of the wet bulb below the standard was greater. Professor ORLEBAR explains this in the following words:—"This seems accountable only on the

supposition that heat is extracted from the air to form the shell of moisture round the wet bulb at a distance as far off as the dry bulb." These discrepancies amounted on the 3rd and 14th of November, at the 19th hour, Göt. mean time:—

Standard . . . 82°·4	Dry . . . 76·5	Wet bulb . . . 71·8	Diff. . . . 5°·9
Standard . . . 82·4	Dry . . . 75·4	Wet bulb . . . 69·3	Diff. . . . 7·0

Professor Orlebar therefore abandoned observing with the attached dry bulb. But supposing this cause of error to have been overlooked by other observers, the tension of vapour and the per-centage humidity would have been recorded by them greatly higher than the truth; and if we apply this source of error to the mean monthly and annual results in the comparative table I have given;—for instance, to the annual mean for Dodabetta, the 90 per cent. is reduced, for the first difference, to 64 per cent., and if the correction be made for 7°, by depression of the dry bulb below a standard owing to its proximity to the wet bulb, the 90 per cent. of moisture at Dodabetta is reduced to 60 per cent. Professor Orlebar says the dry bulb *always* stood below the standard (and he had determined that it was not owing to error in graduation of the thermometers), often to the extent of 2°, and even in the monsoon month of September I observe that on the 2nd it was 3°·4 minus. Any amount of error in depression would necessarily affect the numerical determinations of the tension of vapour and degree of humidity; but supposing it not to exceed 2°, even this small depression would reduce the 90 per cent. of moisture in the air at Dodabetta to 80 per cent. Supposing therefore that the same error was not discovered at the other places of observation as was discovered in Bombay, there is necessarily some ground for the expression of my doubts, whether the air really did hold at the different stations the quantity of moisture represented by the figures I have elaborated. But Professor Orlebar observed another source of error, contingent upon the *locality* of the wet bulb apparatus, whether placed within doors or out of doors. To determine the amount of error he placed a wet bulb *within* the observatory, observing simultaneously with the wet bulb *out* of doors upon the meteorologic stand. This was done hourly for March, April, and to the 10th of May. The reading was almost always plus with the wet bulb inside; on the 22nd of March, at 19th hour, to the extent of 3°·2, while at 18th hour it had been only 0·2 plus; but there were great irregularities in the readings, being plus or minus dependent apparently upon drafts of air within the observatory, which would depress the wet bulb or raise it. Also the "atmosphere within the room would tend to keep up a reading at any time to whatever it had been at a time preceding," and the latter, Professor Orlebar says, was the principal cause of the plus readings in-doors. Supposing this error of 3° to be applied as a correction to the reading of the annual means of the wet bulb at Bombay for 1843, the percentage of moisture in the atmosphere would only be 65 instead of 76. The distinguished experimental philosopher Regnault has pointed out the same sources of error. He placed the dry and wet bulb in the open air in the court of the College of

France, in a closed room in the College, and in the theatre of the College, opening the windows. In the open air, with a temperature ranging from 7°·16 to 17°·88 Centigrade, and a depression ranging from 1°·86 to 9°·60, the results, by observation and by M. REGNAULT's tentative formula*, were sufficiently satisfactory; but in the closed chamber he says, "Les fractions de saturation calculées avec la formule†, sont ici beaucoup plus fortes que celles que l'on deduit des pesées directes de l'eau renfermée dans l'air; en d'autres termes la température t' marquée par le thermomètre mouillé n'est pas assez abaissée par la vaporisation de l'eau que se fait à sa surface pour donner dans la formule la véritable force élastique x de la vapeur. Cette circonstance tient évidemment à ce que l'air se trouve beaucoup moins agité qu'à l'extérieur."—Page 219. At page 220 M. REGNAULT adds, "Ces expériences démontrent de la manière la plus évidente que la formule ne peut pas rester la même pour les divers états d'agitation de l'air."

Here then is a second source of error; and it is somewhat curious that Professor ORLEBAR, in guarding against another grave source of error, which will be adverted to, himself contributes to an error of observation. He had observed the effect of wind blowing upon the wet bulb in unduly depressing the temperature, and to guard against this he says, "As it was equally essential that the bulb of this thermometer should not be exposed to the wind, and that it should be in the same body of air as the air-thermometer when the latter was exposed to the wind, a small mirror, about an inch square, was put on a little stand, and this being placed upon the tin board could be moved about by the observer into such a position that it might always *cut off the wind from the bulb of the wet thermometer* only" (page lxiii.). Now the wet bulb being thus screened, would be buried in its own vapour and the reading would necessarily be too high. When the air is perfectly calm the same would be the result without the screen, for there would be a shell or coat of saturated air round the bulb. I had occasion to notice this local character of aqueous vapour in my Meteorology of the Deccan, where I constantly witnessed it, as regulated in its distribution by nature. Speaking of dew, I said in the year 1828, "At Marheh in the Pergunnah of Mohol, garden produce (which is usually irrigated during the day-time) was covered with a copious dew every morning; the lands bordering the gardens for forty or fifty yards around were slightly sprinkled with it, *but there was not a vestige of it* in the fields constituting the rising ground north and south of the tract of garden land." Hence I inferred that "aqueous vapour had been taken up by the action of the sun during the day, *suspended over the spot*, and deposited by the lower temperature at night as dew upon the land in proportion to the supply obtained by day." My tents were within 200 yards of the fields where I observed these phenomena, but from the 11th to the 30th of January 1828, there was not any deposition of dew about them, excepting on the 13th of January. In consequence of these observations I was induced

* Annales de Chimie, tom. xv. p. 218.

† $x=f'-\frac{0\cdot429(t-t')}{610-t'}H.$

to remark particularly the localities of dew at Poona and in its neighbourhood. In September and October I found that when there was not a trace of dew in the cantonment, there would be a deposition on the fields of standing grain half a mile distant, and when there was not any dew either in the cantonment or in the fields, it would yet be found on the banks of running rivulets and on the banks of the Mota Mola River; but with respect to the rivulets, "*fifteen or twenty feet from the water were the limits of the deposition*." I gave numerous other instances of the local deposition of dew proximate to irrigated lands, or in the neighbourhood of water, indicating the suspension of vapours over the localities, in complete analogy with what occurs to the wet bulb thermometer when the air is calm. That agitation of the air is necessary to disperse the vapour surrounding a wet bulb, has been noticed by British chemists. BRAND says (page 111, last edition), "It is now established that the pressure of air is really an obstacle to evaporation, and that *a current* is useful, not by supplying new quantities of air, but *by removing the vapour* according as it is formed and leaving fresh spaces into which the vapours may expand." He elsewhere says (page 82), "Evaporation is proportional to the surface exposed; it is also accelerated by agitating the superincumbent air, as in the case of a brisk wind, or by artificial means. When the *air is tranquil the vapour rests upon the surface of the water, and it is the pressure of its own vapour on the surface of a liquid, and not that of the gaseous* atmosphere which stops the process." M. REGNAULT has demonstrated the truth of this in an elaborate manner. Accounting for the different results of observations in a closed and open chamber, he says the wet bulb was not sufficiently depressed in the closed chamber. "Cette circonstance tient évidemment à ce que l'air se trouve beaucoup moins agité qu'à l'extérieur*." After experimenting in a room with two windows open, he adds, as before stated, "Ces expériences démontrent de la manière la plus évidente que la formule ne peut pas rester la même pour divers états d'agitation de l'air." (P. 220.) The vapour therefore resting upon the wet bulb is a source of error, but the removal of it leads to one much more grave. M. REGNAULT, in reference to M. AUGUST's formula, says (p. 207), "La formule ne tient aucun compte de la vitesse du courant d'air; d'après cette formule, la différence de température devrait être la même, quelle que soit cette vitesse. Ce résultat parait impossible *à priori*. J'ai cherché à déterminer *par des expériences directes*, l'influence de cette vitesse et à reconnaitre si, à partir d'une certaine valeur de la vitesse, les différences de température des thermomètres sec et mouillé deviendraient indépendentes de la vitesse absolue du courant d'air, conséquence à laquelle on se trouve naturellement conduit par le raisonnement que M. AUGUST applique au calcul de la formule du psychromètre." M. REGNAULT then describes his apparatus and mode of making his experiments. He gives two series of experiments; in the second experiment the air being made to blow upon the wet bulb with a greater velocity than in the first. It will be sufficient to give the first and sixth figures of each series.

* Annales de Chimie, tom. xv. p. 219.

		t*.	t'.	$t-t'$.	
1st series.	1st experiment	14°·66	7°·28	7°·38	Centigrade thermometer.
	2nd experiment	14·96	4·33	10·63	Centigrade thermometer.
2nd series.	1st experiment	21·48	10·78	10·70	Centigrade thermometer.
	2nd experiment	21·70	8·56	13·14	Centigrade thermometer.
In FAHRENHEIT's scale.					
		58·37	45·10	13·27	
		58·93	39·79	19·14	
		70·66	51·40	19·26	
		71·06	47·41	23·65	

In the first series, in the second experiment, the wind blows faster than in the first, and the wet bulb is reduced nearly 3°, and the difference between the wet and dry bulbs is increased from 7°·38 to 10°·63, while the temperature of the dry bulb is only raised 0°·30. In the second series the temperature of the wet bulb is reduced from 10°·78 to 8°·56, and the difference between the wet and dry is increased from 10°·70 to 13°·14, while the temperature of the dry bulb is only raised 0°·22. Upon these experiments M. REGNAULT says, "On voit que, pour une même température t les températures t' dependent beaucoup de la vitesse du courant d'air" (p. 209); and he further says (p. 210) that these depressions are less than he has found on other occasions with an increased velocity of the air; and on using dry air he found the depression $t-t'=13°·52$ instead of 5°·91, and another depression of 15°·60 instead of 8°·60. M. REGNAULT gives other experiments, and finishes by saying, "Il résulte de tout ce qui vient d'être dit, que l'agitation de l'air doit exercir une influence très-sensible sur les indications du psychromètre" (p. 211). The truth of M. REGNAULT's experiments are borne out by the experience of families in the Deccan (and no doubt elsewhere) in India in the fair season, who cool their wine and beer by the following simple process down to a temperature the cold of which makes the teeth ache in drinking. At any time of the day a thick layer of straw is put down on the ground in the shade of a building, but not in the lee of the wind. The bottles of wine or beer to be cooled are put upon the straw, some more straw is thinly and lightly shaken over the prostrate bottles, and the mass is sprinkled at intervals with water through the nozzle of a watering-pot with very fine apertures, thus dewing as it were the straw; the force of evaporation and the consequent cold is proportioned to the velocity and dryness of the wind; but even with a moderate wind the temperature of the liquors is soon greatly lowered; and in certain hot and therefore parching winds, even at a temperature of the air ranging from 85° to 90° FAHR., I have often, at Ahmednugger, had the temperature of the wine or beer (judging from my sensations at the moment) approaching to the freezing-point†. In this cooling process we have

* t. Temperature of dry thermometer. t'. Temperature of wet bulb.

† My sensations deceived me. While this paper is going through the press, I have received from a friend, commanding the Artillery at Ahmednugger, the following results of experiments he made at my request, with

the bottle of wine or beer corresponding to the bulb of the thermometer; the straw lying thinly over it represents the muslin, and the operations of the watering-pot complete the wet bulb apparatus, evaporation does the rest; but as the velocity and dryness of the wind regulate this, it is plain that such an instrument can only give uncertain and fallacious results when used to determine, with any pretension to accuracy, the fractional saturation of the atmosphere. I come now to a source of error in my reductions of the wet bulb observations which I have collected in this paper from various parts in India, a source of error that may operate with a greater or less power as the depression of the wet bulb is greater or less. I allude to the formula used for the reductions of the readings of the wet bulb. M. REGNAULT says that M. GAY-LUSSAC was the first to propose the determination of the dew-point by the observations of a dry and wet bulb apparatus*, but that to effect the object satisfactorily it would require extensive observations upon which to found tables. Subsequently to the period of M. GAY-LUSSAC's proposition, AUGUST, Professor at Berlin, occupied himself with the subject and published some papers, in which he sought to determine, upon theoretical considerations, the formula by which the elastic force of aqueous vapour, really existing in the air, could be found by the difference of temperature of a dry and wet bulb thermometer. The dry and wet bulb apparatus he called a Psychromètre. His chief memoir is published in the Annalen der Physik und Chemie, V. Band. Leipzig, 1825. It will suffice to say that he considered the wet bulb surrounded at all times with a coat of vapour of the same temperature as the bulb, which was, he stated, necessarily lower than that of the surrounding air,—that the successive supplies of air coming into contact with the wet bulb, parted with a portion of their heat and took the temperature of the wet bulb; but on the other hand, the air so supplied in vaporizing the water upon the surface of the wet bulb took from it a portion of its heat; and a stationary state of the temperature of the wet bulb was established by these two quantities of heat balancing each other.

AUGUST's formula was $x = \frac{1+\frac{\gamma}{\delta\lambda}(t-t')}{1+\frac{\varkappa}{\lambda}(t-t')}f' - \frac{\frac{\gamma}{\delta\lambda}(t-t')}{1+\frac{\varkappa}{\lambda}(t-t')}h$, where t denotes the temperature of the dry bulb (in Centigrade degrees), t' the temperature of the wet bulb, γ the specific heat of dry air, δ the density of aqueous vapour, λ the latent heat of aqueous vapour between the temperatures t and t', $\varkappa$ the specific heat of vapour, h the height of the barometer, f' the elastic force of vapour in saturated air at the temperature t', and x the elastic force of the vapour actually existing in the atmosphere; x, f' and h being expressed in inches, or in terms of any common unit.

the wet straw process, on the 21st of May 1850, and preceding days. Temperature of air in shade, free from radiation, 98° FAHR. Temperature of water in bottles under wet straw exposed to wind 65°, difference 33°. The dew-point by APJOHN's formula would be about 41°·7, and by GLAISHER's factors about 48°·5. My friend says, "When the wind does not blow, the temperature of the water in the bottles, under the straw, cannot be got lower than 71° FAHR. When the wind blows, the bottles cool to 65° FAHR."

* Annales de Chimie et de Physique, 2nd series, t. xxi. p. 91.

With assumed values for γ, δ and λ, as the real values are not accurately known, and neglecting small quantities, and supposing $\varkappa=\gamma$, AUGUST's formula became

$$x=f'-\frac{0\cdot428(t-t')}{640-t}h,$$

for the determination of the elastic force and consequently the dew-point, and after certain comparisons of the dew-point from his formula with the direct dew-point from DANIELL's hygrometer, he found what he considered a sufficient agreement between them. In a comparative table* of the results by his formula and the results by DANIELL's hygrometer, they appear to go pretty well together, while the variations of temperature and of the depression of the wet bulb are small; but the moment the temperature exceeds 20° Centigrade (68° FAHR.), and the depression exceeds 5° (9° FAHR.), the discrepancy is very considerable; for instance, at bar. 755·3 millims. (29·736 inches), dry 28°·5 (83°·3 FAHR.), wet 21°·1 (69°·98 FAHR.), depression 7°·4 (13°·32 FAHR.), the tension of vapour by the formula is 14·181 millims. (·558 in. =dew-point 62°), and by DANIELL's hygrometer 12·087 millims. (·475 in.=dew-point 57°·15), the difference 2·094 millims (·083 in.). Even with a depression of only 0·6 (1°·08 FAHR.) the tension of vapour by the formula and by DANIELL is respectively 8·612 millims. (·339 in.), and 8·534 millims. (·335 in.), difference 0·078. These discrepancies induced M. REGNAULT to modify, in 1845, nearly twenty years afterwards, AUGUST's formula, and he in common with AUGUST assumed $\gamma=0\cdot2669$, $\delta=0\cdot622$ and $\varkappa=\gamma$, but $\lambda=610-t$. Substituting these numbers and neglecting small quantities, the formula became $x=f'-\frac{0\cdot429\,(t-t')}{610-t'}h$, and it is this formula that M. REGNAULT tests by his various experiments; and at the close of his able and elaborate paper he says, "Je ne pense pas que l'on puisse admettre comme base du calcul du psychromètre l'hypothèse fondamentale adoptée par AUGUST: à savoir, que tout l'air qui fournit de la chaleur au thermomètre mouillé descend jusqu'à la température t' indiquée par celui-ci, et se sature complètement d'humidité. Il me parait probable que la portion de l'air que se refroidit ne descend pas jusqu'à t', et qu'elle ne se sature pas d'humidité. Le rapport de la quantité de chaleur que l'air enlève à la boule par vaporisation de l'eau, à la quantité de chaleur qu'il perd en se refroidissant, est probablement d'autant plus grand que cet air est plus sec, parceque dans cet état, il est beaucoup plus avide d'humidité que quand il approche de son état de saturation.

"Enfin, la température de la boule mouillée est influencée encore autrement que par l'air immédiatement ambient, elle est soumise au rayonnement de l'enceinte dont l'influence sera variable suivant l'état d'agitation de l'air.

"Il me parait *impossible de faire entrer toutes ces circonstances dans le calcul théoretique de l'instrument*; est je crois qu'il est plus sage de ne faire servir les considérations théoretiques qu'à la recherche de la forme de la fonction, et à *déterminer ensuite les constantes par des expériences* faites dans les conditions déterminées. Cette

* Annalen der Physik, B. v. p. 87.

manière d'opérer me parait d'autant plus nécessaire, *qu'il reste beaucoup d'incertitude sur plusieurs des élements numériques que entrent dans le* calcul, notamment *sur la chaleur spécifique de l'air, sur celle de la vapeur, et sur la chaleur absorbée par l'eau lorsqu'elle se vaporise dans l'air.*"—(P. 212.)

These are the opinions of M. REGNAULT expressed twenty years after AUGUST had invented his formula, and after his own elaborate experiments; and I have preferred giving them in his own language to free myself from any possible misconstruction in translation. M. REGNAULT thought that AUGUST'S formula modified by him, would meet some of the difficulties expressed by him in the above quoted opinions, and he gives tables of results, which, with a limited range of the thermometer and small depressions, are sufficiently satisfactory; but he candidly admits "l'accord a été *beaucoup* moins parfait dans les bas températures et dans l'air très humide;" in these cases M. REGNAULT says the fractions of saturation calculated are always above the fractions of saturation obtained by direct means, often to a very notable extent. M. REGNAULT got one of his pupils to try the psychrometer, under considerably diminished pressure, on the mountains in Switzerland, but the results were so little satisfactory that he does not give a detail of them. He induced also his friend M. IZARN, to compare the readings of the wet bulb in the Pyrenees, at a pressure of 700 millims. (27·559 in.), with the readings of an hygrometer invented by himself, which he calls "hygromètre condenseur," and which he considers to be free from the objections to which DANIELL'S hygrometer is subject; and in a table given, the fractions of saturation are almost always much higher by the wet bulb than by the condenser, the depression in no case exceeding 3°·91. In a depression of 1°·97, the differences of the fraction of saturation are respectively 0·7542 and 0·7937. Finally, M. REGNAULT says that his modified formula may give the elastic force of x a little too high, and that the coefficient 0·480 might be used instead when the fraction of saturation exceeds 0·40 Centigrade, but that the coefficient 0·429 gives results nearer to the truth where the fraction of saturation is below 0·40. When the wet bulb descends below zero, he considers that the value of λ should be increased from 610 to 689, but in the present imperfect knowledge of the true numerical value of several of the elements he will not venture to put forth a new formula for the psychrometer (p. 227). 'Several other philosophers have also given formulæ: BURG from observation, $f''=f'-\cdot0004528(t-t')p$; BOHNENBERGER also from observation, $f''=f'-\cdot0003962(t-t')p$; also KUPFFER, ERMAN and KAMTZ.

On the 24th of November 1834 and 27th of April 1835, Dr. APJOHN of Dublin read to the Royal Irish Academy a very elaborate and able paper upon the theory of the moist bulb hygrometer. The results of his observations, experiments and theoretical considerations, induced him to adopt the formula

$$f''=f'-\frac{d}{87}\times\frac{p}{30}:$$

at p. 436 of the volume of the Proceedings of the Royal Irish Academy for 1840, the formula is

$$f''=f'-\frac{48a(t-t')}{e}\times\frac{p-f'}{30};$$

and finally, with the coefficient

$$f''=f'-\cdot 01147(t-t')\times\frac{p-f'}{30}*;$$

and with this formula† Colonel BOILEAU of the Bengal Engineers, in charge of the Magnetic Observatory at Simla, to aid meteorologists, has calculated a series of tables of the tension of vapour from minus 10° FAHR. to 170° FAHR. for 30° of depression of the wet bulb by tenths, and for variations of pressure from 19 inches to 31 inches. It was these tables I used in the reduction of the preceding wet bulb observations; and it was in the progress of their use, during several months' labour, that at certain temperatures doubts were raised in my mind respecting the accuracy of the formula, from supposing the fraction of saturation unreasonably high when the depression of the wet bulb was inconsiderable, and unreasonably low when the depression of the wet bulb was considerable. The tension of vapour at considerable depressions startled me, until at last I found in testing the tables that with a depression of the wet bulb of 19° at a temperature of 52° FAHR., and at a pressure of 29 or 30 inches, the results became impossible; that is to say, the tension of vapour of the dew-point arrived at by the formula had a greater numerical value than the tension of vapour at the temperature of the wet bulb, *e. g.*

	FAHR.	Bar.	
	°	in.	
Dry bulb	52	30	
Wet bulb	33	. . . .	20640
Difference	19=(a)=·01147 (t—t')=21794		

It is objected that a depression of the *wet* bulb of 19°, at a temperature of 52°, never can occur in nature‡: but very considerable depressions, both of the wet

* APJOHN's formula is expressed in English measures: f'' is the force of aqueous vapour at the dew-point; f' the tension of vapour at the temperature of evaporation; a specific heat of air; e the latent heat of aqueous vapour; d the depression or difference between the temperature of the air and wet bulb $(t-t')$; p the pressure of the air in inches.

† Differing little from AUGUST's formula, and converting it into the measures and scale used by AUGUST; for all practical purposes, the two formulæ are the same.

‡ In a synopsis of nine years' observations of the wet bulb at Mahabuleshwur, the following maximum depressions of the *wet* bulb occur in the respective months of the year:—

Months.	Depression of the wet bulb.	Months.	Depression of the wet bulb.
	°		°
January	17·2	July	5·2
February	24·0	August	7·7
March	24·6	September	8·5
April	26·3	October	16·0
May	26·0	November	15·5
June	7·0	December	16·7

In a preceding page it was shown that water in bottles under wet straw, exposed to the wind at Ahmednugger, cooled down to 65° FAHR., the temperature of the air being 98°, difference 33°, barometer 28 inches, dew-point by APJOHN 41°·7, by GLAISHER 48°·5.

bulb and of the dew-point, have been observed even in our damp climate at the Royal Observatory at Greenwich. For instance, in the records on the 6th of April 1845, at 6 P.M., the dry bulb was 52°·6, wet bulb 39°·2, and *dew-point* by DANIELL's hygrometer 22°. The depression of the wet bulb being 13°·4, the *dew-point* by APJOHN's formula would be 14°, by GLAISHER's factors 25°·8, and by DANIELL's hygrometer it is found to be 22°. Which of these dew-points is to be taken to give the real numerical value of the tension of vapour? At Greenwich, on the 3rd of June 1846, at 4 P.M., the dry bulb was 79°·1, and the dew-point by DANIELL's hygrometer 44°, the depression therefore 35°·1. But I have recorded in the Meteorology of the Deccan, a depression of 61° of DANIELL's hygrometer taking place before the deposition of dew; the temperature of the air being 90°, the dew-point 29°, at 4 P.M., on the 16th of February 1828, at Downd, near Pairgaon, on the Beema River*. Mr. GLAISHER, of the Royal Observatory, a most persevering and able observer, finding from experience that the formulæ in use with a constant coefficient did not give satisfactorily the dew-points at varying temperatures and varying depressions of the wet bulb, adopted a series of factors quite independent of theory, from the results of very extensive comparisons of simultaneous observations of the wet bulb with DANIELL's hygrometer. These comparisons extended over several years, and through several thousand observations. He found that "the dew-point temperature was so related to the temperatures of air and evaporation, that at the same temperature of the air, the difference of temperatures of air and of the dew-point, divided by the difference of the temperature of the air and evaporation, was constant, but that it was different at every different temperature." Arranging several thousand observations made during five years at Greenwich, and during three years at Toronto, and taking the mean value at every degree of temperature, he obtained a series of factors ranging from 8·5 at temperatures below 24° FAHR., up to 1·5 above 70° FAHR.; these were published in the volume of the Greenwich Magnetical and Meteorological Observations for 1842, 1843 and 1844. In 1847 Mr. GLAISHER published hygrometrical tables in which some slight alterations of the original factors were made, and he has since made some further slight modifications. For the limited range in temperature, depression of the wet bulb and pressure, in which the comparisons were made and the factors deduced, they are probably the very best agents (at least above the freezing-point) for giving a close approximation to the true value of the readings of the wet bulb; supposing always the wet bulb not to be subjected to the anomalous indications noticed by Professor ORLEBAR and M. REGNAULT. For considerable differences of barometrical pressure, and very considerable depressions of the wet bulb, the factors would require further correction. When the dew-point was obtained with difficulty by DANIELL's hygrometer, or in other words, when the depression of the temperature of evaporation was great, Mr. GLAISHER found that his method of determining his factors would not hold good, which he attributed to certain objec-

* Philosophical Transactions, Part I. for 1835, p. 184.

tions to DANIELL's hygrometer, and to which it is no doubt subject, but which are applicable to all temperatures and all depressions, objections which were urged by M. REGNAULT, and which induced him to invent his "hygromètre condenseur," an instrument which he pronounces to be free from the errors of DANIELL's instrument, but the use of which I have not heard of in England.

I have thus reviewed, *in extenso*, the possible, indeed the probable sources of error in the very high degree of humidity constantly in the air, as represented by the wet bulb observations made in India, and I have no hesitation in expressing my belief that the results, which I have obtained with the labour of some months, do not represent the real fractions of saturation of the air at the several places where the wet bulb was observed*; and I am the more confirmed in this opinion, with respect to the Neelgherries, by an officer now in London, who resided some time at Ootacamund and kept a meteorological register, who says that if the mean annual moisture in the air had amounted to anything like 90 per cent. it must have been most inconveniently felt in the clothes, hats, bedding and furniture of the residents; but so far from such being the case, that, with the exception of occasional fogs, the hills were looked upon as rather dry than otherwise. From my doubts respecting the correctness of the deduced fraction of saturation of the air at places in India, with the formulæ I have passed in review, I may possibly except the observations made in the Deccan with DANIELL's hygrometer, which observations have a semblance of truth, although the instrument may be imperfect. Even with a comparatively low mean annual percentage of 55 of moisture in the air, I would say such fraction of saturation was rather higher than the truth, for during some months of the year in the Deccan the air is so dry that it is difficult to prevent the disposition of the leaves of tables to curl up into hollow cylinders, and the nib of a quill pen is always most provokingly straddling out into the form of a pair of open compasses.

By reason of the above-noticed sources of error in the wet bulb itself, and of the inadequacy of the formulæ to give a satisfactory value to its readings, supposing the indications to be correct, I have deliberately *not* applied any corrections to the readings of the barometer on account of moisture. But even had the instrument been free from error and the formulæ exact, I still should have deemed it ineffectual to attempt to measure the moisture in a whole column of the atmosphere *from a local observation*† with a view to apply to the barometer, which represents the pressure of an entire column of the atmosphere, a correction for the tension of vapour‡. Further, I have doubts of the propriety of applying to the barometer a correction for

* Dr. M'CLELLAND says, "The wet bulb thermometer would add greatly to the value of these results, but there are discrepancies in the register of the instrument in use (at Calcutta) which *prove it to be imperfect*."—Calcutta Journal of Nat. Hist., vol. v. p. 554.

† "This instrument [wet bulb] simply indicates the conditions of the air of the place where it is situated: at 100 feet above it the conditions may be very different."—GLAISHER's Hygrometrical Tables, p. 16, edition of 1847.

‡ The capacity of air to hold water in solution, or in a state of vapour, diminishes with the temperature.

moisture *subtractively*, even were the tension of vapour satisfactorily determined for the *whole pressure*. The barometer *falls* with increasing saturation of the atmosphere with moisture, indicating the displacement of comparatively dry air by *dilated* vapour, the density of which is less than that of drier air, and a certain amount of pressure is taken off the barometer and the mercury falls on account of the diminished density and elasticity of humid air; but as soon as this vapour is condensed into rain the drier air resumes its ordinary density and elasticity, and the mercury mounts again. If the vapour came simply as an *addition* to the drier air, the density and pressure of the compound should increase, and the barometer should rise; but this is contrary to fact. I would therefore not apply a subtractive correction for that vapour, which has already acted directly upon the barometer in diminishing pressure by displacing denser air. The object of applying any corrections at all to the barometer, on account of moisture in the atmosphere, is stated to be to "obtain from them the pressure of the atmosphere of dry air*;" but as such a state of the air is a physical impossibility as long as there is a drop of water upon the earth to be vaporized, as evaporation goes on at all temperatures, it may be asked, what practical advantage can be obtained from any such determination? and the more so, may the question be asked, when experimenters are not in accord with respect to the numerical values of the tension of vapour at different temperatures to be applied as corrections†.

On the whole it appears very desirable that to DIRECT MEANS recourse should always be had, if possible, for the determination of the dew-point, to DANIELL's hygrometer, or to REGNAULT's condensing hygrometer; and short of this, that persevering comparisons should be made for years, in *extended* ranges of *temperature*, *depression* and *pressure*, and at different elevations, to obtain a more trustworthy wet bulb formula, or an unquestionable series of factors.

Rain.

If it were necessary to suggest caution in generalizations from a limited number of local observations for the determination of the dew-point, caution is equally, if not more necessary in attempting to fix the normal rain-fall even in a narrow area, much less in a district or province. For instance, within the limits of part of the small island of Bombay, seven miles by two miles, the following is the result of observations with nine rain-gauges. The Fort and Esplanade are necessarily proximate; the Observatory at Colabah two miles distant, and the most remote gauge at the Government House at Parell, only five miles from the Fort, the other stations being intermediate between the Fort and Parell.

* GLAISHER's Hygrometrical Tables, p. 12, edition of 1847.

† At 32° FAHR. DALTON's tension of vapour, in inches of mercury, is 0·200, at 95°=1·59297, at 122°=3·500 in. The Physical Committee of the Royal Society adopted for 32° FAHR. 0·186, and for 95°=1·610, and 122° FAHR. 3·542; REGNAULT, at 32° FAHR., has 0·18124, and at 95° FAHR. 1·64380, and at 122°=3·619. KAEMTZ, at 32° FAHR., has 0·17999, and at 95° FAHR. 1·57789; of course different results are come at by the use of these different values.

Bombay, 1849. Rain-fall.

	Colabah Observatory.	Fort.	Esplanade.	Byculla.	Chinchpoogly.	Airy Cottage, Mazagon.	Agricultural garden, Parell.	Parell Flagstaff.	Parell Hill.
	in.	in.	in.	in.	in.	in.	in.	in.	in.
1	0·86	0·36	0·28	0·40	0·00	0·35	0·00	0·00	0·00
2	0·00	0·00	0·00	0·00	0·00	0·04	0·35	0·00	0·30
3	0·39	0·14	0·00	0·06	0·00	0·03	0·05	0·06	0·05
4	0·39	0·55	0·76	0·58	0·00	0·70	0·66	1·23	0·55
5	0·31	0·21	0·12	0·08	0·00 }	1·50 {	0·55	0·80	0·55
6	0·00	0·00	0·00	0·02	0·00 }		0·30	0·46	0·25
7	0·25	0·10	0·06	0·00	0·00	0·00	0·00	0·00	0·00
8	0·00	0·00	0·00	0·04	0·00	0·00	0·10	0·00	0·10
9	0·00	0·03	0·00	0·03	0·00	0·00	0·00	0·00	0·00
10	0·00	0·01	0·00	0·00	0·00	0·00	0·15	0·10	0·20
11	0·16	0·32	0·27	0·88	0·00	0·09	0·30	0·70	0·30
12	3·14	1·78	1·35	1·06	0·00	1·26	0·82	1·92	0·95
13	0·34	0·00	0·00	0·08	4·00†	0·00	1·20	2·16	1·30
14	0·00	0·00	0·00	0·02	1·86	1·70	0·00	0·00	0·00
15	0·00	0·83	1·57	1·43	2·25	0·00	1·25	2·18	1·30
16	4·20	4·65	2·10	3·76	4·75	5·00	3·50	6·79	3·70
17	4·61	2·34	2·60	2·22	2·54	2·25	3·30	7·58	3·35
18	0·65	0·86	1·01	1·09	1·10	0·06	1·35	3·56	1·50
19	0·16	2·25	1·81	1·34	0·75	2·58	1·65	3·38	1·50
20	1·77	5·22	2·20	4·55	4·67	4·70	0·90	1·60	0·70
21	3·34	0·40	0·50	0·43	0·55	0·74	3·95	11·10	4·10
22	4·46	4·28	4·38	3·93	5·11	4·70	3·50	7·66	3·40
23	0·21	0·11	0·10	0·13	0·24	0·30	3·80	5·88	3·70
24	3·62	4·53	5·20	5·22	6·00	6·43	0·43	0·90	0·45
25	3·93	10·51	6·73	7·10*	7·50‡	11·75§	5·40	13·72	5·50
26	5·72	1·26	1·50	0·85	0·85	1·05	4·95	9·00	4·90
27	1·25	1·27	1·86	3·35	2·55	2·70	1·25	1·90	1·25
28	2·22	2·54	3·00	2·28	2·80	3·25	6·25	11·50	6·10
29	2·78	1·90	2·50	2·13	2·20	2·90	2·10	2·85	2·15
30	1·41	1·55	2·15	1·42	2·55	2·70	2·15	3·40	2·40
31	2·47	3·68	4·50	4·57	3·75	4·40	2·35	3·15	2·45
July	48·67	51·68	46·55	49·05	56·02	61·23	52·50	102·14 ‖	53·00
June	23·37	22·82	23·34	19·40	......	25·56	28·54	46·60	26·71
Totals	72·04	74·50	69·89	68·45	......	86·79	81·04	148·74	79·71

It is seen that in June the fall of rain varied from 19·46 in. at Bycalla to 46·60 in. at the flagstaff at Parell, and in July from 46·55 in. on the Esplanade to 102·14 in. at the flagstaff at Parell; or omitting this as a doubtful return, to 61·23 in. at Airy Cottage, Mazagon; and the total of the two months varies from 68·15 in. to 86·79 (omitting the gauge at the Parell flagstaff) at Airy Cottage. I do not know whether the investigations were carried out for a whole monsoon, but in case the discrepancies continued, it would be difficult to determine the normal fall of rain in Bombay. But the anomaly is not confined to Bombay; Dr. Murray, in a paper published in the Journal of the Physical Society of Bombay, No. 9, p. 172, has the following

* Gauge overflowed. † No register kept for first thirteen days—4 inches set down at guess.

‡ Gauge overflowed.

§ The gauge was running over, but this seems pretty nearly all that fell. It poured in torrents from 5 P.M. on the 25th till 6 A.M. 26th.

‖ The difference here is the same as last month (twice as much of fall being set down here as fell everywhere else); and so enormous and unaccountable as to lead to the inference of some tremendous blunder.

observations respecting the fall of rain in the town of Sattarah and military cantonment adjoining: "The quantity of rain in the town of Sattarah usually exceeds that in the cantonment, situated a mile N.E., by 6 or 8 inches." Annexed are the results, to which he has added the fall at his own bungalow or house, equidistant between the town and cantonment, so that the three localities are within the range of a mile.

Years.	1844.	1845.	1846.	1847.	1848.
Town Hospital	......	44·39	42·92	43·17	33·41
Dr. Murray's bungalow	36·06	40·24	39·52	40·98	
Cantonment Hospital	......	38·34	31·65	39·00	27·81
Hill Fort, above the town of Sattarah...	......	......	......	......	39·36

The increased fall of rain in the town of Sattarah, which is 2320 feet above the sea-level, is no doubt chiefly caused by the hill, 3200 feet above the sea-level, upon which the fort is situated, rising from the back of the town; but this will not account for the difference in the fall at the Bungalow and Cantonment Hospital. The facts show how necessary is a local knowledge of physical features before generalizations can be ventured upon safely.

In my former paper in the Philosophical Transactions I pointed out the remarkable differences in the fall of rain, twenty to twenty-five years ago on the sea coast, at the top of the Ghâts, and at Poona, thirty-five miles to the eastward of the Ghâts. Dr. Murray confirms my views in a much more detailed manner than I was enabled to attempt, in the following Table for the year 1848:—

	Bombay.	Ghâts.		Western Districts.							Eastern districts.				
		Mahabuleshwur.				Sattarah.									
	Means of 33 years.	Sanatarium, means 14 years.	Sindola, 1848.	Meera.	Enteshwar.	Hill Fort.	Town.	Cantonment.	Bhore.	Wye.	Phultun.	Jhutt.	Bijapoor.	Punderpoor.	Akalkote.
January	......	0·05													
February......	......	0·20													
March.........	......	0·15	......	......	......	......	0·80	0·04							
April	......	1·31	......	......	......	......	0·74	0·76							
May	......	3·31	3·60	2·75	2·60	2·50	3·04	2·79	2·10	2·09	6·24	......	......	0·75	1·83
June	22·26	46·53	41·70	10·93	5·98	4·10	3·71	3·26	2·37	2·20	4·30	1·59	0·80	2·02	3·68
July	25·04	92·10	74·28	22·90	19·83	18·77	14·64	12·02	13·20	9·05	2·70	3·07	3·67	4·38	4·65
August	17·08	72·33	47·81	6·16	6·02	5·00	2·60	2·55	5·19	1·61	1·24	4·82	8·52	6·21	4·83
September ...	11·25	31·32	6·17	2·30	1·80	1·46	2·14	1·40	0·91	0·96	3·66	2·64	4·01	4·35	2·84
October	1·19	4·58	7·23	2·75	2·27	4·64	4·89	3·28	1·50	2·75	2·45	3·88	4·64	8·35	5·32
November ...	......	2·07	4·37	1·85	0·19	2·91	1·57	1·71	4·15	2·25	3·59	2·17	3·78	2·49	2·30
December ...	......	0·05													
Year	76·82	254·05	185·16	49·64	38·69	39·38	33·41	27·81	29·42	20·73	24·18	18·17	25·42	28·55	25·45

With the exception of Bombay and the Sanatarium at Mahabuleshwur, the records are for the year 1848. The following are the respective elevations of the places above the sea-level:—

Mahabuleshwur.	Sindola.	Meera.	Enteshwar.	Sattarah Fort.	Sattarah Town.	Sattarah Cantonment.	Bhore.	Wye.	Phultun.	Jhutt.	Bijapoor.	Punderpoor.	Akalkote.
4500	4600	2340	3700	3200	2320	2320	2350?	2320?	2000?	2000?	2000?	2000?	2000?

Dr. MURRAY adds, "The prodigious influence of the Ghâts in modifying the amount of the S.W. monsoon rain, is perhaps nowhere more strikingly shown than in the N.W. parts of the Sattarah territory. If we draw a line nearly straight from west to east, from Mahabuleshwur, on the summit of the Ghâts, to Phultun, a distance of little more than forty miles, we shall find at the commencement of the line a rain-fall of 240 inches, at an altitude of 4500 feet; 180 inches at Sindola, *a mile distant*, and elevated 4600 feet; 50 inches at Paunchgunnee, at a further distance of eleven miles and an elevation of 4000 feet; 25 inches at Wye, four miles further east and 2300 feet in height above the sea, while at the extremity of the line at Phultun, thirty miles from Sattarah, and about the same level as Wye, the quantity is reduced to 7 or 8 inches." But Dr. MURRAY must have meant during the S.W. monsoon, as he had previously represented the fall of rain at Phultun at 24·18 in. in 1848, in 1847 at 24·04 in., and in 1846 at 18·09 in. Some inches of those amounts however are attributable to the Madras monsoon, which commences in October, when the Malabar coast monsoon terminates, and Phultun, from its easterly position, gets an uncertain sprinkling from the Madras side.

Dr. MURRAY, with a view to show not only the discrepancies in the total annual fall of rain at places within comparatively limited distances situated on the plateau of the Deccan, but the remarkable contrasts in the monthly fall at two proximate places, has given the following Table of the fall of rain at Sattarah and Phultun for 1846 and 1847, Phultun being thirty miles east of Sattarah:—

	Sattarah.		Phultun.	
	1846.	1847.	1846.	1847.
January	0·18			
February	0·18	......	......	0·02
March	......	0·18	......	0·52
April	......	10·88	1·44	4·19
May	3·49	0·39	1·06	2·88
June	10·49	3·77	3·80	1·53
July	16·04	6·28	1·95	0·84
August	2·13	2·68	......	0·50
September	0·77	3·55	1·05	2·00
October	2·98	5·25	2·50	3·06
November	0·98	8·00	5·04	4·60
December	2·46	0·05	1·53	0·89
Year	39·52	40·98	18·09	24·04

Dr. MURRAY, in a paper published in the autumn Number of the Journal of the Physical Society of Bombay for 1849, adds to the proofs of the extraordinary discrepancies in the fall of rain in proximate localities. He states (page 18), "At the Sanatarium at Mahabuleshwur, at 4500 feet, the rain-fall during 1848 was 245 inches, being within 3 inches of the average fall during the preceding twenty years. At Sindola, the residence of Mr. FRERE (the British minister), situated *a mile* east from

the Sanatarium, about 100 feet higher, with the *intervening* eminence of Mount Charlotte rising to a further height of 100 feet, the quantity of rain did not exceed 185 inches during the same period; hence a difference of 60 inches or 24 per cent. at two houses *situated at the same station.* The position of the ground explains the difference, but probably few people, on examining the localities, would have anticipated its amount. It shows the supreme importance of instituting multiplied observations, before deciding on the site of a sanitary hill station."

To add to the means of comparison, some other rain-fall localities from the sea-coast, and Konkun, or country between the Ghâts and the sea,—from the Ghâts and from the plateau of the Deccan, are annexed, being the mean fall for the years 1844–47.

Sea-coast of Konkun.		Konkun, somewhat inland.		Western Ghâts.		Western Ghâts, East branch.	Deccan.							
Bombay, sea-level.	Rutnagherry, 150 feet.	Tanna, sea-level.	Dapoolee, 900 feet.	Kundalla, 1740 feet, 1833 and 1835.	Mahabuleshwur, 4500 feet.	Paunchgunnee, 4000 feet, 1835, 1842 and 1843.	Sattarah, 2320 feet.	Kolapoor, 1847.	Poona, 1842 feet.	Nassick.	Belgaum, 2000 feet.	Dharwar.	Ahmednugger, 1900 feet.	Sholapoor, 1847.
68·73	114·55	106·16	134·96	141·59	254·84	50·69	39·20	20·74	19·02	26·72	40·90	38·81	21·83	32·16

Tanna and Dapoolee are situated between the sea-coast and the foot of the Ghâts. Kundalla is on the crest of the Ghâts on the high road from Bombay to Poona. The places in the Deccan lie eastward of the Ghâts. Arranging the above places according to their supply of rain, it appears the greatest fall is on the crest of the Ghâts, increasing from 141·59 inches at Kundalla at 1740 feet to a mean fall of 254·84 inches at Mahabuleshwur, at 4500 feet. From the crest of the Ghâts the supply of rain decreases towards the sea-coast westward, but decreases in an infinitely greater ratio eastward on the plateau of the Deccan. Along the coast the supply of rain diminishes with the increase in latitude.

In further illustration of the unequal fall of rain in the Bombay Presidency, the returns for May, June and July 1849 are annexed. They are the latest I have received except from Bombay.

	Bombay.	Poona.	Surat.	Nassick.	Asseerghur.	Ahmedabad.	Phoonda Ghât.	Mahabuleshwur.	Paunchgunnee.	Calcutta.
May	0·00	0·405	0·00	0·00	0·23	2·03	0·00	0·00	......	6·00
June	22·82	9·055	11·16	8·63	5·45	4·10	50·00	59·90	......	13·0
July	51·68	6·425	19·00	7·03	16·31	7·62	83·00	89·24	......	8·25
Total	74·50	15·885	30·16	15·66	21·99	13·75	133·00	149·14	11·95	27·25

To General CULLEN of the Madras Artillery, and British minister, with the Rajah of Travancore, I am indebted for the following comparison of rain-fall at stations on the coast of Malabar and Coromandel:—

	Years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
20 feet. Cochin.	1842.	...	...	...	3·05	25·07	25·05	13·70	21·95	10·15	3·55	3·65	......	105·27
	1843.	5·15	...	2·00	4·50	27·15	37·32	21·05	4·27	7·75	9·45	0·10	5·75	124·49
	1844.	...	0·45	1·70	1·70	19·35	22·42	19·10	11·75	2·37	17·55	4·50	1·07	101·97
	1845.	3·42	...	5·80	2·20	3·57	31·37	16·10	11·22	1·67	11·85	0·92	4·45	92·60
	1846.	0·02	...	0·70	4·80	19·70	37·32	16·72	16·27	2·15	5·95	2·25	0·10	106·00
Means	......	1·72	0·09	2·04	3·25	18·97	30·69	17·33	13·09	4·82	9·67	2·28	2·27	106·06
30 feet. Quilon.	1842.	...	1·17	1·32	3·30	22·24	16·00	8·65	8·60	7·42	4·87	7·47	......	81·06
	1843.	1·42	0·47	0·50	9·85	24·62	26·52	20·72	7·45	5·15	5·85	2·15	1·00	105·72
	1844.	...	...	0·55	0·70	8·15	15·55	5·75	6·70	2·37	13·95	3·25	3·60	60·57
	1845.	3·30	...	4·65	0·25	4·85	13·80	9·55	3·95	0·45	15·35	1·85	3·70	61·70
	1846.	...	...	2·90	1·60	22·70	17·65	10·55	3·80	1·30	9·40	4·75	0·10	74·75
Means	......	0·94	0·33	1·98	3·14	16·51	17·90	11·04	6·10	3·34	9·88	3·89	1·68	76·76
30 feet. Allepy.	1842.	1·15	0·25	2·92	2·50	27·67	20·00	10·60	12·30	7·57	12·95	6·50	0·10	104·52
	1843.	3·20	0·75	6·90	5·75	30·12	32·80	21·57	5·22	9·72	9·12	0·90	5·77	131·85
	1844.	0·37	2·87	2·55	3·00	24·33	23·12	16·60	10·42	4·92	15·37	9·90	5·40	118·70
	1845.	4·92	0·50	8·80	2·65	17·80	25·20	11·92	6·47	1·00	9·67	4·35	4·50	97·80
	1846.	0·00	1·70	0·20	3·15	31·45	29·00	12·45	12·27	3·42	13·00	5·77	1·00	113·43
Means	......	1·93	1·21	4·27	3·41	26·27	26·02	14·63	9·33	5·32	12·02	5·48	3·35	113·26
50 feet. Cape Comorin.	1843.	0·90	...	...	...	6·50	0·80	0·95	......	0·65	4·80	......	4·60	19·20
	1844.	...	...	...	...	1·20	3·00	......	......	1·00	7·50	4·60	2·20	19·50
	1845.	0·20	...	0·90	...	1·30	2·20	0·70	......	......	10·70	1·40	Heavy shower	18·00
	1846.	...	...	2·80	3·30	9·40	12·25	1·20	1·45	......	12·10	9·82	4·40	56·72
Means	......	0·27	...	0·92	0·75	4·55	4·56	0·71	0·36	0·41	8·77	3·95	2·80	28·35
60 feet. Vaurioor, close to Cape Comorin.	1842.	0·35	0·65	...	...	2·25	1·20	......	0·40	1·82	4·35	9·25	......	20·27
	1843.	1·40	1·00	0·75	0·40	9·90	2·05	0·80	0·10	0·35	4·15	0·45	4·40	25·75
	1844.	...	0·50	0·20	...	0·90	3·00	0·80	......	0·15	7·45	3·70	1·35	18·05
	1845.	2·75	...	3·65	...	1·70	1·45	2·70	......	0·35	12·92	2·40	8·90	36·82
	1846.	...	...	0·90	1·65	5·20	2·90	0·55	......	......	4·00	5·50	1·75	22·45
Means	......	0·90	0·43	1·10	0·41	3·99	2·12	0·97	0·10	0·53	6·57	4·26	3·28	24·67
130 feet. Trevandrum.	1842.	3·70	0·35	0·85	3·60	13·70	9·50	4·25	3·75	6·30	3·05	8·30	0·35	57·70
	1843.	0·80	0·02	2·52	8·80	17·12	16·62	12·90	2·55	3·10	7·52	2·05	11·42	85·45
	1844.	...	...	1·10	0·30	4·55	6·15	3·80	5·67	3·75	15·17	4·40	2·15	47·05
	1845.	4·40	0·77	3·40	0·85	4·55	15·80	4·30	0·90	0·15	18·52	3·92	5·00	62·57
	1846.	0·10	...	1·07	4·02	11·42	17·75	6·92	3·67	0·75	17·50	4·40	2·30	69·92
Means	......	1·80	0·23	1·79	3·51	10·27	13·16	6·53	3·31	2·81	12·35	4·61	4·24	64·54
200 feet. Palemcottah.	1842.	1·20	0·19	1·05	0·45	0·55	0·02	0·01	0·03	2·50	6·60	9·62	0·95	23·12
	1843.	4·02	2·50	0·77	1·20	5·65	......	......	......	......	7·15	1·65	3·95	26·90
	1844.	0·20	0·55	...	0·75	0·10	1·17	0·05	......	1·75	2·65	1·70	2·76	11·68
	1845.	0·43	...	5·27	0·55	1·62	0·15	......	......	0·65	6·17	2·02	8·75	25·63
	1846.	0·80	1·35	0·57	2·30	4·05	0·07	0·07	......	0·30	1·80	5·97	0·65	17·75
Means	......	1·33	0·92	1·53	1·05	2·39	0·28	0·03	0·006	1·05	4·87	4·19	3·41	21·06
600 or 700 feet. Shenkottah.	1842.	1·20	1·30	...	2·05	3·90	5·65	2·80	1·40	3·10	3·20	14·85	......	39·45
	1843.	4·15	0·80	2·45	4·15	11·20	4·80	6·20	1·05	1·15	7·15	1·50	3·50	48·10
	1844.	...	...	2·40	...	0·50	3·60	......	1·80	1·60	6·25	4·25	3·70	24·10
	1845.	2·00	...	4·40	2·20	......	3·80	4·65	0·35	......	15·40	4·05	5·85	42·70
	1846.	0·57	...	0·70	4·65	6·20	8·60	3·40	1·10	2·50	5·95	4·47	3·45	41·60
Means	......	1·58	0·42	1·99	2·61	4·36	5·29	3·41	1·14	1·67	7·59	5·82	3·30	39·19

The stations extend along the Travancore or western coast from Cape Comorin, lat. 8° 4′, to Cochin, lat. 10° 30′. Of the three stations on the Tinnevally or Coromandel coast, Shenkottah is near Courtallum, immediately at the east base of the Ghâts, and about sixty miles from the sea-coast of Travancore; Palamcottah is about thirty miles from the east base of the Ghâts, is sixty miles from the western coast, and in the latitude of Quilon; Vaurioor is only three miles north and a little east of Cape Comorin. The western and eastern stations are separated by the Ghâts, which in some places rise to a height of 6000 feet, but within ten miles of Cape Comorin they break off into separate groups and peaks of greatly diminished height.

Bearing in mind the preceding extraordinary discrepancies, not only in the annual and monthly fall of rain in the same locality and in proximate localities, I proceed to place in juxtaposition the fall of rain at various places in India, from such returns as are within my reach, from places at the sea-level and at different elevations above the sea-level; and it may well be a question how far even the means of many years' observations in any one locality, exhibit normal conditions for the fall of rain in circumscribed areas, much less for districts or provinces.

The relative positions of the stations on the Malabar and Coromandel coasts having been previously stated, it only remains to notice the places somewhat inland. Poona, at 1823 feet, is about forty miles eastward of the western scarp of the Ghâts, and about sixty miles as the crow flies from the sea-shore. Kotergherry, at 6100 feet, is part of the Neelgherry mountains, and lies a little to the eastward of the ridges of Dodabetta at a lower level of 2340 feet. Dodabetta is part of the Neelgherries, and the highest point of the peninsula of India. Mahabuleshwur, Mercara and Uttra Mullay, at the common level of 4500 feet, are nearly in the same meridian, but lie between 9° and 18° north latitude, and are situated near to the western scarp of the Ghâts. (See annexed Table.)

The first feature of this Table is the almost total want of rain at every station in the month of February, with the exception of Kotergherry and Dodabetta, and it may be accounted for by this month being intermediate between the times of the S.W. and N.E. monsoons; the former, on the Malabar coast, commencing in May and ending in October, and the latter commencing on the Coromandel coast in October and ending in January. The other two intermediate months, March and April, have very limited falls of rain, excepting at Kotergherry, Uttray Mullay and Dodabetta, at which places the supply is very liberal; indeed at Kotergherry and Dodabetta the maximum monthly fall of the year appears to occur in April, a month that belongs to neither the Malabar nor Coromandel monsoons, but as the wind at Dodabetta was almost entirely from northerly and easterly points, the supply of rain may be more reasonably considered to appertain to the tail of the N.E., rather than to the commencement of the S.W. monsoon. Poona, at 1823 feet, and Mahabuleshwur in the Deccan and Mercara in Coorg, at 4500 feet, have scarcely a sprinkling from the N.E. monsoon, and the months of December, January, February, March and April, may be

	Madras, sea-level.					Calcutta, 18 feet.									Bombay, sea-level.	Cochin, 20 feet.
						4 feet.	40 feet.	4 feet.	40 feet.	4 feet.	4 feet.	4 feet.	4 feet.	40 feet.		
	1842.	1843.	1844.	1845.	Means of 22 years, 1822 to 1843.	1843.	1843.	1844.	1844.	1845.	1846.	1847.	1848.	1848.	Means of 32 years, 1817 to 1849. Monsoons.	Means, 1842 to 1846.
January	1·76	6·40	0·67	1·51	1·33	1·67	1·55	0·22	0·20	1·10	0·82	0·0	0·0	0·0	......	1·72
February ...	0·0	0·03	0·49	0·0	0·23	0·64	0·49	0·08	0·05	0·64	1·80	0·0	0·0	0·10	......	0·09
March.........	0·25	0·79	0·0	0·04	0·36	1·20	0·92	0·22	0·15	1·17	2·30	0·0	0·41	0·32	......	2·04
April	0·00	0·04	0·00	0·04	0·63	2·42	2·04	3·13	2·63	7·30	0·57	2·33	1·31	1·12	......	3·25
May	0·37	14·07	2·70	1·51	1·03	5·33	4·43	7·44	6·29	2·58	2·49	4·79	6·22	5·51	......	18·97
June	1·51	1·93	2·66	2·36	2·03	8·64	7·62	12·13	9·95	10·66	12·14	12·01	13·52	12·68	22·26	30·69
July	3·42	1·39	3·22	2·90	3·20	10·18	8·67	13·72	11·40	12·80	20·07	15·69	17·50	16·09	25·04	17·33
August	3·07	2·20	2·66	2·01	5·24	20·05	17·99	26·91	22·89	15·36	13·26	15·09	9·22	7·00	17·08	13·09
September ...	5·56	4·14	12·42	4·09	4·76	11·19	9·92	5·02	4·25	4·80	9·97	10·95	4·74	4·10	11·25	4·82
October	7·99	6·25	13·50	3·36	10·09	2·16	1·88	4·99	4·54	5·86	10·76	5·86	5·41	5·18	*1·19	9·67
November ...	12·32	5·27	3·67	5·12	12·42	0·0	0·0	0·0	0·0	0·0	0·74	5·59	0·20	0·13	......	2·28
December ...	0·19	7·25	2·32	15·33	3·25	0·86	0·79	0·0	0·0	0·81	1·52	0·05	0·16	0·09	......	2·27
Year	36·39	49·76	44·31	38·27	44·57	64·34	56·30	73·86	62·35	63·08	76·44	72·38	58·69	52·32	76·82	106·06

Malabar Coast.				Cape Comorin, 50 feet.	Coromandel Coast.				Poona, 1823 feet.					Mahabuleshwur, 4500	
Cochin, 20 feet.	Quilon, 30 feet.	Allepy, 30 feet.	Trevandrum, 130 feet.		Vaurioor, 60 feet.	Palamcottah, 200 feet.	Shenkottah, 600 or 700 feet.	Kotergherry, 6100 feet.							
Means, 1842 to 1846.	Means, 1842 to 1846.	Means, 1842 to 1846.	Means, 1842 to 1846.	1843 to 1846.	Means, 1842, 1843.	Means, 1842 to 1846.	Means, 1842 to 1846.	1847.	1826.	1827.	1828.	1829.	1830.	Means of 15 years.	1834.
1·72	0·94	1·93	1·80	0·27	0·90	1·33	1·58	1·74	0·0	2·29	0·0	0·0	0·0	0·05	0·0
0·09	0·33	1·21	0·23	......	0·43	0·92	0·42	13·88	0·0	0·0	0·0	0·0	0·0	0·25	0·25
2·04	1·98	4·27	1·79	0·92	1·10	1·53	1·99	6·88	0·0	0·4	0·0	0·0	0·0	0·15	0·0
3·25	3·14	3·41	3·51	0·75	0·41	1·05	2·61	18·56	0·0	0·0	0·0	0·0	1·04	1·31	Two showers.
18·97	16·51	26·27	10·27	4·55	3·99	2·39	4·36	No record.	3·41	0·04	1·95	2·74	0·79	3·31	0·16
30·69	17·90	26·02	13·66	4·56	2·12	0·28	5·29	0·41	3·30	13·47	1·63	4·86	5·57	46·53	32·03
17·33	11·04	14·63	6·53	0·71	0·97	0·003	3·41	3·70	8·43	1·79	7·58	4·38	5·35	92·10	118·60
13·09	6·10	9·33	3·31	0·36	0·12	0·006	1·14	2·66	1·03	2·01	3·35	3·21	1·72	72·33	75·91
4·82	3·34	5·32	2·81	0·41	0·53	1·05	1·67	1·36	1·54	4·51	6·92	0·33	0·29	31·32	65·97
9·67	9·88	12·02	12·35	8·77	6·51	4·87	7·59	12·33	1·90	4·33	6·34	1·81	3·07	4·58	9·29
2·28	3·89	5·48	4·61	3·95	4·26	4·19	5·82	10·62	2·33	0·15	2·04	0·0	0·0	2·07	0·0
2·27	1·68	3·35	4·24	2·80	3·28	3·41	3·30	9·57	0·40	0·0	0·0	1·20	0·0	0·05	One light shower.
106·06	76·76	113·26	64·54	28·35	24·67	21·06	39·19	81·71	22·34	28·63	29·81	18·53	17·83	254·05	302·21

* This average is for the monsoon months only.

hwur, 4500 feet.		Mercara in Coorg, 4500 feet.	Uttray Mullay. 4500 feet.		Doda-betta. 8640 feet.	
1834.	1842.	Means, 1838 to 1840.	1845.	1846.	1847, 1848.	
0·0	0·66	0·00	8·40	4·65	0·12	January.
0·25	0·0	0·45	0·15	0·45	7·43	February.
0·0	0·02	1·51	14·20	0·73	3·61	March.
'wo showers.	0·0	2·60	1·37	9·60	19·80	April.
0·16	3·74	7·37	22·68	36·50	4·86	May.
32·03	37·86	30·40	52·15	51·05	4·55	June.
18·60	117·76	55·88	50·15	33·32	7·45	July.
75·91	77·75	27·00	25·57	21·12	9·32	August.
65·97	56·00	11·91	8·08	7·33	7·52	September.
9·29	7·48	4·60	70·70	38·25	12·49	October.
0·0	4·00	1·38	16·10	21·67	11·85	November.
'ne light shower.	0·0	0·25	21·00	10·20	12·28	December.
02·21	305·27	143·35	298·55	235·87	101·24	Year.

considered their dry months; but Mercara, lying much further south than Mahabuleshwur, would appear to benefit slightly from the terminal falls of the N.E. monsoon, or from the preliminary squalls of the S.W. monsoon. On the eastern or Coromandel coast, the months that are comparatively dry (or rather destitute of rain, for the wet bulb won't admit them to be dry) on the western coast, are necessarily the reverse of the eastern, and we thus see October, November, December and January, at Madras, and the other stations on the east coast, with a monthly fall of rain ranging from 0·90 to 15·13 inches. The mean annual fall at Madras, for twenty-two years, from 1822 to 1843, ranges from 18·45 inches in 1832 to 88·68 inches in 1827. Calcutta, although within the regular S.W. monsoon, appears to benefit more from the Coromandel monsoon in January than any other of the stations noticed in the Table. The Tables indicate that as the stations approximate towards each other, and lie nearer to the apex of the triangular-formed peninsula of India, excepting at Cape Comorin, so do they respectively benefit in an increasing ratio from the monsoons of either coast. For instance, Madras derives considerable advantage from the Malabar monsoon in the months of July, August and September, while Cochin, Quilon, Allepy and Trevandrum, on the Malabar coast, and the mountain stations of Uttray Mullay, Kotergherry and Dodabetta, lying between the Malabar and Coromandel coasts, are liberally supplied from the N.E. monsoon in the months of October, November and December, while Mercara and Mahabuleshwur, similarly situated as Uttray Mullay and Dodabetta, but in a higher latitude, and nearly in the same meridian, derive scarcely any benefit from the N.E. monsoon; indeed, north of the eighteenth parallel of latitude, that is to say of Poona, the rain-fall of the N.E. monsoon does not extend, at least as far as the returns I have been able to collect afford me the means of judging. Another feature of the Table indicates that the S.W. monsoon does not burst simultaneously along the whole line of the Malabar coast, but would appear to creep up slowly from Allepy towards Bombay, commencing in fact on the coast of Travancore partly in April, but absolutely in May, and rarely, if ever, commencing in Bombay before the first week in June; the S.W. monsoon therefore on the coast of Travancore and Malabar, precedes the time of its occurrence at Bombay by a month at least. I had thought that along the coast the quantity of rain diminished as the latitude increased, and the large annual fall at Allepy and Cochin, compared with the fall at Bombay, seemed to justify the opinion; but the fall at Cape Comorin, Trevandrum and Quilon, does not justify the opinion; and supposing that any such law held good on the Malabar coast, it plainly has not any existence on the Coromandel coast. It is certain, however, that as the tropic is approached on the western side of India, the annual fall of rain sensibly diminishes along the coasts of Kattywar and Cutch; and at the mouths of the Indus, not only is there no trace of the S.W. monsoon, but Lower Scinde would appear to resemble those singular tracts on the earth, the Deserts of Sahara and Gobi, and the coast of Chili, denominated "rainless." I regret not having been enabled to get more than one re-

gular meteorological register from the military cantonment at Kurrachee, situated near one of the mouths of the Indus; but the scanty information supplied to me affords sufficient proof that if Lower Scinde does not belong absolutely to the rainless districts, it approaches very nearly to them. Unfortunately, neither in the large cantonment at Kurrachee, nor at other stations in Scinde, up to 1849 were regular meteorological registers kept, excepting perhaps for mere temperature, or if kept they were not made available to the public. Casual observations have been made and sufficient attention paid to the rain-fall, or rather the absence of it, to enable us to say definitely, that to Lower Scinde the S.W. monsoon, in its usual sense, does not extend, and that the country does not appear to have other sources of supply. The following Table is arranged from the details in a letter dated Kurrachee, July 6th, 1848, noticing the occasional showers that fell from April 1847, a pluviometer having been set up, but apparently for very little purpose :—

Register of Rain at Kurrachee, from April 1847 to July 1848.

1847.								1848.						
May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March.	April.	May.	June.	July.
None.	None.	A shower.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	A few drops.

It thus appears, if the register be correct, that in fifteen months only two showers occurred, and those so light as not to be appreciable by the pluviometer.

The following extract from a subsequent letter, dated 1st of September 1849, to a certain extent is in harmony with the previous record :—

"We have had a few smart showers lately. Ever since June it has been constantly threatening rain; the sky has been always overcast, and both in July and August showers fell, but the whole fall for the season has hardly amounted to 3 inches; and yet in Upper Scinde, at Mooltan, in the Punjab, and generally in India, where the S.W. monsoon prevails, the usual averages have in some places been doubled."

In this year, at Bombay, the unusual quantity of 118·88 inches fell. The only other part of Scinde from which I have any record is from Kotri near to Hyderabad on the Indus, and the return transmitted to me is annexed. The public duties of the observer called him occasionally away from his station and prevented a continuous record, and it is only for 1846 that a year's observations are complete, and in 1847 four months were omitted.

Extract from a journal kept at Kotri near Hyderabad on the Indus, by Mr. STRATH, engineer; for the months entered the blanks indicate the months of no observation.

	1845.	1846.	1847.	1848.	1849.
January	......	None.	None.	......	None.
February ...	......	None.	......	......	None.
March	......	*	None.	......	0·35 in.
April	......	None.	†	......	||
May	......	1·75 in.	None.		
June	......	6·33 in.			
July	......	0·27 in.			
August	......	None.	‡		
September ...	......	None.	None.	None.	
October	......	None.	None.	§	
November ...	......	None.	None.	None.	
December ...	None.	None.	None.	None.	
		8·35 in.			0·35 in.

I am enabled, however, since the preceding notices were written, by the arrival in England of the medical returns from the Bombay army for 1847, to give an official and authentic record of the rain-fall and temperature at Kurrachee for 1847. It will be seen that for *eleven* months not a single shower fell, and that in one month only did rain fall, the record being in accord so far with the letter dated 6th of July 1848, differing, however, inasmuch as the rain in the official report is represented to have fallen in June and the latter in July.

1847.	Thermometer.			Rain.	Rain.
	Max.	Min.	Mean.	in.	
January	83°	53°	67°		On 24th, 25th and 31st.
February ...	74	59	67		
March	84	70	77		
April	84	75	79		Heavy showers, 23rd and 24th.
May	90	77	83		On 24th and 25th.
June	94	80	87	3·0	
July	90	78	84		Slight showers.
August	95	82	88		
September ...	90	80	86		
October	93	72	80		
November ...	91	59	72		
December ...	83	44	63		
Mean	88·42	69·08	77·75		

In a review of the above rain-records we find some singular features. Along the western coast of India, from Cape Comorin to the mouth of the Indus, there is a paucity of rain at the former place, and an almost total absence of it at the latter,

* On the 4th of this month a few drops of rain fell at sunset.

† Rain during the night and light showers during the day.

‡ At sunset drops of rain.

§ At P.M. of the 7th heavy showers of rain with wind, thunder and lightning.

|| On the 30th light showers.

while a few miles from Cape Comorin the annual supply amounts to 113 inches; and in the latitude of Bombay it does not fall below a mean of 76·82 inches for the monsoon alone, but proceeding along the coast northwards the supply further diminishes, or becomes irregular and uncertain in quantity, and at the mouths of the Indus almost disappears. Along the Coromandel coast the N.E. monsoon does not appear to supply much more than one-half of the fall on the Malabar coast, the mean of twenty-two years at Madras being 44·57 inches, the quantity slightly increasing with the latitude from Cape Comorin. Another marked feature is the greatly increased fall of rain with the increased elevation above the sea-level of the place of observation up to a certain height, beyond which the quantity of rain gradually diminishes as the place of observation is more elevated; at least such are the indications in the tract of land which lies between the sea-shore and the base of the Ghâts between Cape Comorin and Goozerat, and along the western face of the Ghâts themselves. The observation does not hold good however on the elevated lands to the eastward of the crest of the Bombay and Malabar Ghâts. Along the sea-coast the falls vary from 28·35 inches at Cape Comorin to 113·26 inches at Allepy, but increase at stations nearing the Ghâts at different elevations to more than 300 inches at 4500 feet, and above that height the falls gradually diminish in quantity. For instance, the

	inches.
Mean of seven stations at sea-level, western coast, is	81·70
At 150 feet, Rutnagherry, in the Konkun	114·55
At 900 feet, Dapoolee, Southern Konkun	134·96
At 1740 feet, Kundalla, the pass from Bombay to Poona	141·59
At 4500 feet, Mahabuleshwur, means of fifteen years	254·05
At 4500 feet, Mercara in Coorg, means of three years	143·35
At 4500 feet, Uttray Mullay*, in Travancore, means of two years .	263·21
At 6100 feet, Kotergherry, on the Neelgherries, one year	81·71
At 8640 feet, Dodabetta, highest point of Western India, one year	101·24

Hence the elevation of the line of maximum fall would appear to be about 4500 feet, and above this level the supply of rain is diminished; Mahabuleshwur, Mercara and Uttray Mullay, although differing greatly in latitude, lie nearly in the same meridian, and are all at the same elevation. The comparative small fall at Mercara is accounted for by the fact of its not being so near the western scarp of the Ghâts as Mahabuleshwur and Uttray Mullay, and the effect of a station being placed a few

* Since the above was written I have received a letter from General Cullen, dated Trevandrum, 6th of January 1850, giving an account of the fall of rain for 1849 at the Uttray Mullay range.

	inches.
At 500 feet, base of range	99
At 2200 feet, Attagherry	170
At 4500 feet, Uttray Mullay	240
At 6200 feet, Agusta Peak	194

Showing at 6200 feet a fall of 46 inches less of rain than at 4500 feet.

miles east of the Ghâts upon the fall of rain has already been shown at Mahabuleshwur and Paunchgunny, the latter place being eleven miles eastward of the former, and at a lower level of only 500 feet, yet the mean fall of 15 years at Mahabuleshwur was 254·05 inches, and of the latter 50·69 inches. In 1849 the contrast was still greater, the fall at Mahabuleshwur amounting to the enormous quantity of 338·38 inches, while at Paunchgunny only 58 inches fell.

Rain at different Elevations.

Mr. Miller, in his Meteorology of the Lake Districts of Cumberland and Westmoreland, has adduced sufficient evidence to prove that the same law, if it be a law, obtains in England in mountainous districts, but Mr. Miller's elevation of maximum fall is about 2000 feet instead of 4500, as in India. This difference no doubt results from the differences of latitude and consequent mean temperature, and would indicate that the stratum of vapour supplying the maximum quantity of rain floats at a less height beyond the tropics than within them.

In a communication from Mr. Miller, dated June 7, 1849, he gives as follows the fall of rain at different heights in the Lake Districts of Cumberland and Westmoreland.

"The Mountain Gauges.

No.		In 13 months. 31st of December 1847 to 31st of December 1848.	Summer months. 1st of May to 31st of October.	Winter months. December 1847 to April 1848, and November and December 1848.
		in.	in.	in.
XXI.	Sca Fell Pike, 3166 feet above the sea	64·73	49·46	
		From 1st of May.		
XXII.	Great Gable, 2928 feet above the sea	91·32	46·81	44·51
XXIII.	Sprinkling Tarn, 1900 feet above the sea	148·59	70·95	77·64
XXIV.	Stye Head, 1290 feet above the sea	138·72	60·35	78·37
XXV.	Brunt Rigg, 500 feet above the sea	109·19	43·18	66·01
XIV.	Valley to the west, Wastdale	127·47	50·16	77·81
XIII.	Valley to the S.E., Eskdale	95·71	37·69	58·02
XXVI.	Seatollar Common, } 1334 feet above the sea	139·48	57·97	81·51
XIX.	Valley, Seathwaite, } Borrowdale	177·55	68·96	108·59

"From the table for the summer months, it appears that between the 1st of May and the 31st of October, the gauge at 1290 feet has received 20½ per cent. more rain than the valley; at 1334 feet, 15½ per cent. more; at 1900 feet, 41½ per cent. more; at 2928 feet, 6 per cent. less; and at 3166 feet, 1 per cent. less than the valley.

"In the winter months, the gauge at 1290 feet has collected 0·5 per cent. more; at 1344 feet, 5½ per cent. more; at 1900 feet, 1 per cent. more; and at 2928 feet, 42½ per cent. less than the adjacent valley."

These results are in accordance with the observations I have given from India. In addition to the preceding from Mr. Miller, I annex his rain-records at lower levels

for the years 1845, 1846, 1847 and 1848, as they confirm, from European localities, the facts I have stated respecting the great discrepancies in the fall of rain at proximate stations.

Fall of Rain in the Lake Districts of Cumberland and Westmoreland at various heights up to 3166 feet. Wind almost uniformly from a westerly quarter.

Years.	Whitehaven.			The Flosh, 3 miles south of Whitehaven.	Keswick, 258 feet.	Cockermouth.	Bassenthwaite Hills, 210 feet.	Vale of Gillerthwaite, Ennerdale, 286 feet.	Loweswater, 336 feet.	Foot of Crummock Lake, 283 feet.	Gatesgarth, Buttermere, 326 feet.	Eskdale.		Wastdale Head, 166 feet.	Westmoreland.			Borrowdale.			
	High Street, 90 feet.	Round Close, 480 feet.	Saint James's Church Steeple, 78 feet.									Centre of Vale, 166 feet.	Head of Vale.		The How, Troutbeck, 300 feet.	Ambleside, 190 feet.	Langdale Head, 250 feet.	Seathwaite, in Garden, at 6 inches, 1334 feet.	Seathwaite, in the Field, at 18 inches, 1334 feet.	Stonethwaite.	Seatollar Common, 1334 feet.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1848.	47·342	46·700	36·344	60·82	66·407	52·37	47·06	97·73	76·668	98·07	133·55	86·78	70·38	115·32	91·347	76·82	130·38	160·89	157·22	130·24	139·48
1847.	42·921	42·023	30·713	47·80	58·286	42·55	44·45	80·13	66·209	82·32	106·25	58·66	74·93	96·34	78·004	......	112·95	129·24	126·80	106·21	
1846.	49·134	......	35·422	55·16	67·678	52·41	......	83·87	70·249	96·47	121·90	......	......	106·93	77·719	......	127·40	143·51			
1845.	49·207	......	33·480	53·00	62·212	46·93	......	76·88	69·542	87·48	124·13	......	......	108·55	76·305	......	136·00	151·87			

These records attest that in the town of Whitehaven the difference in the fall of rain in the High Street and on the steeple of St. James's Church in 1845, was 15·727 inches, and in 1848 the difference was 10·998 inches, while at the Flosh, only three miles south of Whitehaven, the fall was in excess in those years respectively over the fall in the High Street, 2·873 inches and 13·478 inches, while the excess over the fall on the steeple was 19·600 inches and 24·476 inches. In Borrowdale also, in a field adjoining a garden, in the years 1847 and 1848, the fall was in excess in the garden of 2·44 inches and 3·67 inches respectively. These facts suggest caution to all observers in other parts of England and elsewhere.

Professor Phillips for some years made observations at York on the top of the Minster, the Museum, and on the ground, to determine the effect of elevation upon the rain-fall, but objections being taken to the results in respect to eddies of wind and other causes of error, he lifted rain-gauges into the air, independently of buildings, and the results of the observations for the years 1843 and 1844 he communicated to the British Association at York in 1844.

The sums of the rain-fall in the two years at different heights were,—

	inches.
24 feet.	24·158
12 feet.	26·039
6 feet.	26·109
3 feet.	26·298
$1\frac{1}{2}$ foot.	26·559

The nearer the earth, therefore, the greater the amount of rain collected. Mr. Miller's records at Whitehaven, giving for four years the amount of rain collected in the High Street and on the Church Steeple, confirm Professor Phillips's observations, supposing the steeple to be 78 feet above the High Street. At Calcutta, in the

Surveyor-General's Office, similar observations were made at the respective heights of 4 feet and 40 feet, and I have inserted the results in the general rain-fall Table for four years. The sums were respectively 261·97 inches and 247·41 inches, and the annual means 65·49 inches and 61·85 inches.

Dr. BUIST states that at the observatory in Bombay, in two rain-gauges, one at 3 feet from the ground, and the other above the observatory at 32 feet, the

	inches.
Lower gauge for 1843 . . .	=56·24
Upper gauge for 1843 . . .	=49·07
Lower gauge for 1844 . . .	=66·51
Upper gauge for 1844 . . .	=66·08

These results therefore are in accordance with Professor PHILLIPS and Mr. MILLER's observations, taken at limited heights, but entirely antagonist to Mr. MILLER's own observations and those I have supplied in this paper from India for heights exceeding a few hundred feet. The supposed law may hold good for small differences in elevation on the plains, but the law is reversed in mountainous districts.

Two great features of my Rain-table demand express notice, the paucity of rain at Cape Comorin and at Kurrachee, at the extremities of nearly the same meridional line, and the prodigious fall of rain at the elevation of 4500 feet at three stations differing greatly in latitude, but situated nearly in the same meridian. I have not any satisfactory explanation to offer of the want of rain either at Cape Comorin or at Kurrachee. I am not at all acquainted with the physical character of the country about Cape Comorin, and cannot therefore express an opinion how far local circumstances occasion the phenomenon. I had thought that a very high mean temperature, with a limited range of the thermometer, might account for the want of rain at Kurrachee on the Indus, the vapour from the ocean not coming into an air cold enough to condense it; but the register of the thermometer for 1847 at Kurrachee shows that I could not found a satisfactory argument upon its records, for the maxima are not so great as at Calcutta, Madras and Bombay; the minima are lower, and the mean temperature is lower than at either of the places; some other cause therefore must be looked for than a high mean temperature. The clouds which constantly pass over Kurrachee, would appear not to be condensed until they impinge upon the Sulimanee Mountains, which run parallel to the right bank of the Indus. The explanation of the prodigious fall of rain at the level of 4500 feet is simple and satisfactory. The chief stratum of aqueous vapour brought from the equator by the S.W. monsoon is of a high temperature, and floats at a *lower* level than 4500 feet; indeed I have looked over, or upon the upper surface of the stratum at 2000 feet. It is dashed with considerable violence against the western mural faces of the Ghâts, and is thrown up by these barriers in accumulated masses into a colder region than that in which it naturally floats; it is consequently rapidly condensed and rain falls in floods. The uncondensed vapour which escapes up the chasms and over the crest of the Ghâts,

affords the precarious and scanty supply to the lands to the eastward, which the Tables show.

Maximum Daily Rain-Fall.

As might be looked for, the greatest fall of rain in any one day is met with in the records of those stations where there is the greatest annual fall, Mahabuleshwur and Uttray Mullay. At the former station the greatest fall in any one day in fifteen years was 13·06 inches on the 2nd of September 1833, but the months of June, July and August, have numerous instances of a daily fall of 11·32 inches, 12·76 inches, and 12·69 inches in those months respectively. The greatest monthly fall at Mahabuleshwur was 134·42 inches in July 1840. At Uttray Mullay the greatest daily fall in three years was 15·1 inches on the 14th of October 1845. On the 11th of December of the same year there was a fall in one day of 11·4 inches, and on the 9th of October 1844 the fall in one day was 9·0 inches. In 1846 there was not a daily fall approaching these figures. In Bombay, in 1845, the greatest daily fall was 4·71 inches on the 24th of July, and the next year, on the 16th of July, a daily fall occurred of 5·16 inches; but Dr. Buist mentions that on the 1st of July 1844 there was a fall of rain in twenty-four hours of 7·44 inches, two inches having fallen in seventy minutes; but this was on the first burst of the monsoon, which set in later than usual by three weeks. On the 10th of July, however, 9·43 inches fell, the greatest of the year. In the Deccan there is rarely a greater daily fall than two inches, but in the Sattarah records a maximum daily fall of 4·40 inches in four years is stated to have occurred in April; but this was in one of the squalls which are the precursors of the monsoon. Annexed is a comparison of the fall of rain in Bombay and at Mahabuleshwur for many years.

Register of the Pluviometer at Bombay, from the year 1817 to 1849.

Years.	June.	July.	August.	September.	October.	Total fall in June, July, August, September, and October of each year.	Mahabuleshwur, 4500 feet.
	in.	in.	in.	in.	in.	in.	
1817.	45·72	23·67	9·34	24·87	......	103·60	
1818.	22·54	17·69	28·45	10·39	2·07	81·14	
1819.	15·95	31·66	20·24	10·11	......	77·96	
1820.	18·82	28·37	29·49	10·66	......	77·34	
1821.	15·18	20·60	28·52	18·29	......	82·59	
1822.	29·64	26·59	33·83	22·16	......	112·22	
1823.	21·76	15·96	19·70	4·28	......	61·70	
1824.	3·89	8·07	17·86	1·78	2·37	33·97	
1825.	24·45	25·17	12·94	9·68	......	72·24	
1826.	17·75	26·97	8·40	23·50	1·87	78·49	
1827.	49·15	10·29	10·51	10·16	0·92	81·03	
1828.	23·53	52·75	17·22	22·08	6·40	121·98	
1829.	27·86	19·78	12·40	4·95	0·66	65·65	257·06
1830.	20·96	32·46	10·66	7·78	......	71·86	232·93
1831.	22·46	27·31	27·64	22·34	2·08	101·83	185·82
1832.	13·63	48·05	4·65	7·11	0·65	74·09	226·87
1833.	12·50	21·80	13·35	23·54	0·20	71·39	203·74
1834.	14·16	21·83	18·05	12·55	3·88	70·47	297·31
1835.	9·99	4·27	35·76	12·17	0·42	62·61	226·71
1836.	21·36	24·53	37·41	4·69	......	87·99	243·56
1837.	12·61	24·39	22·43	5·15	......	64·58	267·76
1838.	29·70	8·70	7·34	5·04	......	50·78	180·17
1839.	18·28	32·19	18·45	4·70	......	73·62	233·23
1840.	25·04	24·24	4·20	7·55	2·12	63·15	284·43
1841.	25·27	21·21	20·53	1·27	3·21	71·49	281·04
1842.	16·84	26·45	37·10	10·41	4·36	95·16	304·90
1843.	9·33	22·49	18·20	9·00	0·25	59·27	285·67
1844.	14·17	35·52	6·55	9·16	......	65·40	262·32
1845.	19·70	20·44	6·56	8·03	......	54·73	249·93
1846.	31·71	40·56	5·60	8·45	1·16	87·48	288·34
1847.	35·47	16·80	8·92	5·80	0·32	67·31	218·83
1848.	42·37	13·83	7·87	4·01	5·34	73·42	245·01
1849.	22·82	51·68	13·66	29·65	1·07	118·88	338·38
Average for 33 years.	22·26	25·04	17·08	11·25	1·19	76·82	

Note.—The Bombay register is only for the months of the monsoon, and it does not appear that any record has been kept of the fall in the other months annually. The record at Mahabuleshwur is for the whole year.

Winds at Madras.

Direction of the Wind at Madras, blowing from the different *quarters* of the compass, from hourly observations.

	1841.				1842.				1843.				1844.				1845.			
	N.W.	S.W.	S.E.	N.E.	N.W.	S.W.	S.E.	N.E.	N.W.	S.W.	S.E.	N.E.	N.W.	S.W.	S.E.	N.E.	N.W.	S.W.	S.E.	N.E.
Jan....	...	...	...	...	105	51	80	508	74	29	92	549	64	47	193	440	87	27	196	434
Feb....	...	...	...	...	95	124	227	229	23	82	434	133	45	92	309	249	11	71	393	197
March	2	170	372	0	26	201	276	1	15	179	527	23	12	266	449	17	13	221	477	33
April	120	471	115	14	0	307	269	0	0	230	488	2	15	236	451	19	3	380	335	2
May	57	407	219	37	56	468	211	9	73	376	260	35	67	426	215	36	73	437	204	30
June	86	539	86	9	86	447	133	30	88	553	76	3	196	397	84	43	228	396	51	45
July...	144	511	76	13	96	578	62	13	121	562	54	7	127	498	111	8	128	498	108	10
Aug.	85	352	288	19	37	487	144	26	120	494	117	3	200	411	95	38	135	472	129	8
Sept.	115	356	182	43	91	377	174	76	153	355	168	44	114	359	187	60	93	371	228	28
Oct....	265	93	145	241	101	203	221	219	194	183	119	248	171	251	125	197	83	274	229	158
Nov.	232	16	58	414	139	16	34	531	194	2	11	513	236	0	51	433	96	0	66	558
Dec.	219	0	10	515	157	16	70	501	207	19	144	374	246	8	64	426	149	14	104	477
Total	...	...	...	...	1039	3275	1901	2145	1262	3064	2490	1934	1493	2991	2340	1966	1099	3161	2520	1980

Note.—N.W. includes the winds blowing between N. and W. points, and the same applies to the other quarters.

The prevailing wind at Madras is the S.W., which wind brings to Bombay and the Malabar coast their monsoon rains, but which to Madras becomes mostly a *hot* wind after traversing the peninsula, and carries with it to Madras only a few showers. The S.W. wind begins to prevail at Madras over every other wind in the month of April, and mostly remains the dominant wind until the end of September: the S.E. wind then prevails until October, about the middle of which month the approaching N.E. or rainy monsoon of the Coromandel coast almost displaces the S.E. wind. Its full development takes place in November, and it remains the prevailing wind until February, when the S.E. regains its influence, and is greatly the dominant wind until April, when it is gradually displaced by the S.W. wind. The N.W. wind makes its appearance in every month of the year, chiefly in the months of the S.W. or Malabar monsoon, but least so in the months of March and April, in the years 1841 not in March, and 1842 not at all in April; the N.E. wind failed in the same months in the respective years. The N.W. is the quarter from whence Madras has the smallest amount of wind. The largely prevailing wind is the S.W., which, coming up from the equator, is the chief source of rain supply to India generally, but of which the Coromandel coast gets but a scanty proportion in consequence of the high western Ghâts intercepting and condensing the chief part of the vapour brought by that wind. The next prevailing wind is the S.E., and this equally blows from the equator upon Madras and the Coromandel coast; but it is nevertheless not the rain-bearing wind of the Madras monsoon, which is from the N.E., sweeping over the bay of Bengal from Burmah. The S.W. wind from the Indian Ocean is a rain-bearing wind, but

the S.E. wind, also from the Indian Ocean, is not a rain-bearing wind in the sense of a monsoon. By a comparison of the Wind-table with the Rain-table of Madras, it will be seen that in the months in which the S.E. winds prevail, February, March, April, September, and early part of October, the first three months are almost entirely rainless, and the little that falls in September is owing to occasional S.W. winds. This may be owing to the air over the peninsula in those months, from the position of the sun in the ecliptic being too hot to condense the S.E. vapour. On the contrary, the N.E. wind from the bay of Bengal comes loaded with vapour in November, December and January, and the sun being far south, the peninsula is rapidly cooling, and the vapour from the bay of Bengal being of a higher temperature than the air upon which it is thrown, is condensed. The valuable table from the Madras Observatory shows by inspection, the gradual changes of the wind from one quarter to another, and the total annual numbers under each quarter show considerable uniformity in successive years.

Winds at Bombay.

The following Table of the winds at Bombay, for the year 1843, is from the *hourly* observations taken by Dr. Buist, LL.D. Although the numbers of hours at which the winds blew are placed under the points N.W., S.W., S.E., N.E., the numbers embrace the winds within each quarter of the compass; for instance, N.W. embraces all the winds blowing between N. and W., and so on for the other quarters.

	N.W.	S.W.	S.E.	N.E.
January	382	56	11	157
February	397	15	32	132
March	451	30	28	138
April	442	94	17	47
May	380	273	12	1
June	.85	438	73	7
July	133	491	0	0
August	184	460	2	3
September	98	390	43	53
October	280	41	50	253
November	224	1	51	348
December	130	0	64	382
Year	3184	2289	383	1521

The Table shows that the prevailing wind at Bombay, in 1843, was from the points between N. and W., having blown at 3184 hours. The next prevailing wind is from the points between S. and W., having blown for 2289 hours, being the rain-bearing wind of the so-called S.W. monsoon, from May to September inclusive; but in truth the wind most generally blows from the W.S.W., with a leaning to a point more westward, and a S.W. and by S. wind during the monsoon is of rare occurrence. The wind from the points between N. and E. is the next most prevalent. It begins to prevail in October, and continues prevalent as long as the N.E. monsoon blows at

Madras, on the opposite coast of India; it may be said to cease entirely when the Malabar monsoon approaches in May. The S.E. wind, unlike Madras, is little felt at Bombay, having blown at 383 hours only during 1843. Few as the occasions are on which it blew at Bombay, it would appear to have resulted from the veering of the N.E. wind through E. to a point southward of east; a wind strictly from the S. is scarcely known at Bombay. The N.W. wind, which is the dominant wind at Bombay and the least prevailing wind at Madras, blows at Bombay most in those months when it is least felt at Madras, namely, the first five months of the year, and in the months of March and April it almost disappears at Madras; but at Bombay in those months it blows at more hours than any other wind blows in any other two months of the year, excepting probably the W.S.W. in July and August. In January, February, March, April, and up to the third week in May, the wind from the N. to W. points blows from eleven to twenty-two hours daily, the remaining hours having the wind from the N. to E. points, constituting the land-wind, the N.W. being considered the sea-breeze. In part of October, November and December, the reverse is the case, the N.E. or land-wind prevailing from thirteen to nineteen hours daily, and the sea-breezes appearing between noon and 10 P.M. The suddenness with which the prevailing winds commence and terminate is a marked feature in the meteorology of Bombay. The wind from the S. to W. points begins suddenly the third or fourth week in May, and as suddenly terminates in the first or second week of October. The wind from the N. to E. points takes the place of the S.W. wind and terminates suddenly in May. The N.W. wind, owing to its being a daily alternating wind with the land-breeze, from the heating action of the sun upon the land daily, has a more continuous character throughout the year, appearing even in the monsoon months, when a few days' sunshine heats the land; it is however much less frequent in those months than when the sun bears with continued force upon the land.

Winds at Calcutta.

With regard to the winds at Calcutta, Dr. J. M'CLELLAND, in the fifth volume of the Calcutta Journal of Natural History, has given a reduction of the meteorological register kept at the Surveyor-General's Office, Calcutta, from the 31st of October 1843 to the 31st of October 1844; from his paper the following extracts are made in a condensed form:—

	Wind at noon.			
	N.W.	S.W.	S.E.	N.E.
1843.				
November	26	1	0	3
December	24	0	0	5
1844.				
January	25	0	3	3
February	23	2	0	4
March	1	20	8	0
April	0	26	3	1
May	0	24	4	3
June	5	21	3	2
July	1	17	11	1
August	1	17	13	0
September	4	19	5	2
October	4	7	6	3
Year	114	154	56	27

As these observations are only for noon in each day of the year, they are of little value; supposing them however to be typical of the variations of the wind, there is a certain accordance with the winds at Madras and Bombay in the respective months of the year, with respect to the winds blowing between the points S. and W., and with Bombay in the winds blowing between the points N. and W., excepting that the latter cease to prevail in March in Calcutta, but do not relax in Bombay until June. The winds of the S.W. monsoon would appear to commence in March in Calcutta, but not until May in Bombay. The tendency of the N.W. and S.W. winds in Calcutta, however, is rather to blow, the former from the N. and the latter from the S., than from intermediate points; out of 353 observations, the wind blew sixty-eight times from the N. and ninety-one times from the S., while the N.W. blew only thirty-four times and the S.W. wind only forty-two times. Judging from the Table, Calcutta is little affected by the winds of the N.E. monsoon. There is only a single instance of "no wind" at noon during the whole twelve months.

The following Table shows the direction of the wind at six different hours, and the relative duration of each wind throughout the year:—

	N.	N.W.	W.	S.W.	S.	S.E.	E.	N.E.	Calm.	No. of observations.
Sunrise	32	16	7	19	68	29	25	20	137	353
$9^h\ 50^m$ A.M.	59	29	42	49	75	34	23	37	3	351
Noon	58	34	53	42	90	19	29	26	1	352
$2^h\ 40^m$ P.M.	52	40	58	27	105	20	20	24	6	352
4^h P.M.	53	42	45	36	93	34	31	12	6	352
Sunset	56	18	11	23	116	23	17	9	78	341
Total	310	179	216	190	536	150	145	118	231	2101
Proportion of each	51·6	29·8	36	32·6	89·3	26·5	24·1	19·6	38·5	350

From this Table the S.W. monsoon, which at Bombay has a disposition chiefly to

blow half a point to the westward of W.S.W., at Calcutta blows chiefly from the S., and the prevailing N.W. wind of Bombay becomes a northerly wind in Calcutta. The Table shows that almost the only hours of calm are at sunrise and at sunset.

Winds at Mahabuleshwur.

At Mahabuleshwur, at 4500 feet above the sea-level, the following is the mean monthly direction of the wind, as given by Dr. MURRAY in a synoptical view of fifteen years' observations:—

	Direction.	Force.
January	Easterly.	Moderate.
February	E.N.E., N.N.W.	Moderate.
March	N.E., N.N.W.	Moderate.
April	N.E., N.N.W.	Moderate.
May	N.E., N.N.W.	Moderate.
June	W.S.W.	Moderate.
July	W.S.W.	High.
August	W.S.W.	High.
September	W.S.W.	Moderate.
October	Variable.	Light.
November	Easterly.	High.
December	Easterly.	High.

From the generalities in the Table, it would not be safe to deduce any normal conditions from comparisons with the wind tables of Madras, Calcutta or Bombay. In the months of January, November and December, Mahabuleshwur would appear to share more largely in the easterly winds of Madras than in the N.W. winds of Bombay in those months; but in February, March, April and May, and the rest of the year, the station would appear to have much the same winds as prevail at Bombay. Its elevated position, therefore, does not remove it from the periodic currents of air of a lower level. Even Dodabetta, at its great elevation of 8640 feet, is partly subject to the periodic winds of Madras and Bombay, at least as far as one year's record of observations recorded *hourly* from OSLER's anemometer enables us to judge.

Winds at Dodabetta.

	N.W.	S.W.	S.E.	N.E.
1847.				
February	5	0	17	6
March	4	0	2	25
April	7	3	2	18
May	3	8	2	18
June	4	26	0	0
July	18	13	0	0
August	27	0	1	3
September	21	5	0	4
October	9	0	12	10
November	5	7	3	15
December	6	0	8	17
1848.				
January	2	0	16	13
Year	111	62	63	129

The winds of the S.W. monsoon, however, terminate in July instead of October. This is the more remarkable, as Dodabetta lies between Madras, where these winds are the prevailing winds of May, June, July, August and September, and Bombay, where the same winds prevail in the same months. It is probable, therefore, that Dodabetta is situated just above the upper surface of the stratum of wind and aqueous vapour which supplies the S.W. monsoon to Western India, and therefore has comparatively a small supply of rain from this source. But it is not situated (although on the western coast) above the stratum of wind and aqueous vapour which supplies the Coromandel coast during the N.E. monsoon, as it has the same prevailing winds between the N. and E. points in the same months as at Madras, from October to February, when the N.E. ceases at Madras, but continues at Dodabetta until late in May. The *prevalence* of winds from points between N. and W. in the months of July, August and September, is peculiar to Dodabetta: neither Mahabuleshwur, at 4500 feet, nor Madras, Bombay nor Calcutta has similar indications. However, as this so-denominated N.W. wind very frequently blows from only one or two points to the northward of west, the wind may belong to the monsoon of Western India, local physical circumstances having given it a slant. On the whole it may be said, that the peninsula of India, in its length and breadth and the atmosphere over it to the height of nearly 9000 feet, is subject to periodic winds; but at widely separated places, varying a point or two from the apparent normal winds, and commencing or terminating a week or two earlier or later. May, June, July, August and September have prevailing winds from points between W. and S.; October, November, December, January and February have prevailing winds from points between N. and E.; February, March and April, at Madras, have a prevailing wind from points between S. and E., as opposed to Bombay, where the wind in those months prevails from points between N. and W., with rare instances of a S.E. wind; while at Calcutta the N.W. wind terminates in February; but a series for years of hourly observations, like those at Madras, are necessary to give that confidence which cannot be given to deductions from the meteorological data at present available from India.

It is usually understood that very high winds materially depress the barometer, but the records at Dodabetta do not support this view. On the 17th and 18th of April 1847, the wind blew with a mean pressure of 21 lbs., and 14 lbs. respectively upon the square foot; but the barometer only fell from 21·955 on the 16th to 21·917 on the 17th, and rose to 21·984 on the 18th; and there was a maximum pressure from the wind on the 17th at one time of 35 lbs. 26th of May, maximum wind 28·5 lbs., barometer not affected more than 0·010 inch; 12th of June 30 lbs., 26th of July 32 lbs., 10th of September 35 lbs., and 14th of October 22 lbs.; but these pressures of the wind had little or no effect upon the barometer.

Fogs.

In the Madras observations there is not any mention made of fogs; and Captain Ludlow of the Madras Engineers, who recorded the observations, tells me that fogs are almost unknown at Madras, the nearest approach to a fog being an occasional mist on the ground, not visible more than 3 feet above the surface.

	Madras.	Bombay. 1843.	Calcutta, 1843–44.	Mahabuleshwur, 15 years.	Dodabetta, 1847–48.	
	Fogs.	Fogs.	Fogs.	Fogs.	Fogs.	Dense fog.
January	0	0	5	0	0	5
February	0	0	3	0	11	9
March	0	0	4	0	4	0
April	0	0	4	0	1	4
May	0	0	0	Foggy last half.	6	1
June	0	0	0	Foggy.	16	2
July	0	0	1	Continued dense fogs.	2	9
August	0	0	0	Continued dense fogs.	5	20
September	0	0	0	Frequent light fogs.	2	15
October	0	0	1	First half light fogs.	2	29
November	0	0	0	0	3	26
December	0	0	2	0	1	16
Year	0	0	20	0	53	136

At Bombay there are not any records of fogs in the hourly observations for 1843 nor 1844, but Dr. Buist informs me that mists are of regular occurrence in March; they begin early in February and continue for five or six weeks. They disappear after sunset, and are slightest from sunrise to noon*. At Calcutta, from Dr. M'Clelland's Report, there were only twenty instances in 1843–44, almost entirely at sunrise. At Mahabuleshwur, from the latter end of May until the middle of October, there is almost a continued fog with deluges of rain. At Dodabetta the prevalence of fogs is very remarkable, there being no less than 136 records of dense fogs and 53 of light fogs during the year. Of the dense fogs 52 occurred at 9^h 40^m A.M. and 85 at 3^h 40^m P.M.; 27 light fogs at 9^h 40^m A.M. and 25 at 3^h 40^m P.M.

Electricity.

I have not any data of a character to enable me to speak satisfactorily on the subject of the electric state of the air at the several stations.

I conclude with a rapid analysis of the preceding Tables.

In my paper published in the Philosophical Transactions in 1835 upon the Meteorology of the Deccan, I arrived at the following conclusions:—That Humboldt was mistaken in supposing, upon the authority of Horsburgh, that the diurnal atmo-

* I presume Dr. Buist means misty and comparatively semi-transparent *heated* air, as distinct from fogs.

spheric tides were suspended during the monsoon in Western India. The fact was also unquestionably established of the existence of four atmospheric tides within twenty-four hours,—two diurnal and two nocturnal, each consisting of a maximum and minimum tide, and the occurrence of these tides within the same limit hours as in America and Europe; the greatest mean diurnal oscillations taking place in the coldest months, and the smallest tides in the damp months of the monsoon in the Deccan, whilst at Madras the smallest oscillations were in the hottest months: it was shown also that these tides took place regularly without a single instance of interruption, whatever the thermometric or hygrometric indications might be, or whatever the state of the weather, even storms and hurricanes only modifying and not interrupting them. The anomalous fact was also shown of the mean diurnal oscillations being greater at Poona, at an elevation of 1823 feet, than at the level of the sea, in a lower latitude at Madras or Bombay, while at an elevation greater than Poona, the mean diurnal oscillations were *less* than at Poona. It was shown also that the seasons did not affect the limit hours of the tides; but it was shown at the same time that the turning-points of the tides were sometimes irregular; that a tide flowed for a longer or shorter period, and that there were numerous cases of a stationary state of the atmosphere at the hours when the tides should turn. It was shown that the maximum mean pressure of the atmosphere was greatest in December or January, gradually diminished to June, July or August, and subsequently increased to the coldest months. The trifling daily and annual range of the barometer, compared with the ranges in extra-tropical climates, was shown; also the more limited annual range of the thermometer in the Deccan than in Europe, but the existence of a greater daily range; the maximum mean temperature was in April or May, and then gradually declined to the coldest months; very considerable differences in the dewing-points within very narrow areas were shown; dew being frequently local and occurring under anomalous circumstances, and the great contrast between the dewing-points, on the sea-coast at Bombay and in the Deccan, was pointed out; the rain in the Deccan was not more than 28 per cent. of the quantity that fell in Bombay; the winds principally westerly and easterly, rarely from due north or south; and finally, the rarity of fogs was stated.

It is very satisfactory to find in the discussion of the meteorological observations in the present paper, from a very extended area, from different heights and from observations, some of which are hourly, and which run through several years at the same station, that after an interval of twenty years the accuracy of the former deductions should be established almost to the letter; but as some of the observations now discussed were from hourly records, continued through considerable periods of time, an opportunity has been afforded of investigating abnormal conditions, which the former limited number of diurnal observations did not permit; and from these sources a rapid review of what appear to be normal and abnormal conditions is now appended.—1st. The annual and daily range of the barometer diminishes from the sea-level up to

the greatest height observed, 8640 feet at Dodabetta, from a mean annual and mean daily range at Madras of 0·735 and 0·122 to 0·410 and 0·060 at Dodabetta;—the annual range would appear to increase, about and beyond the northern tropic, as the annual range at Calcutta (not by hourly observations) is 0·911 : but the diurnal range is somewhat less (0·115) than at Madras. At no one of the places of observation, even taking the maximum pressure of one year with the minimum pressure of another year, does there appear to have been a range of pressure equivalent to an inch of mercury; nevertheless in the Cyclones, or rotatory storms, there occurs at times a range of pressure of nearly 2 inches of mercury within forty-eight hours; but it is shown from a comparison of the simultaneous records on board ship, where these great depressions were noted, with the records at the observatories on shore, that the great depressions occurred within very limited areas.

I had formerly shown that the times or turning-points of ebb and flow (if the terms be permitted) of the aërial ocean were occasionally retarded or accelerated, although the means fixed the turning-points within certain limit hours; but I was not aware that in the ebb or flow of the four daily tides, they ever retrograded or halted in their onward or retiring course. The hourly observations now satisfy us that abnormal conditions are of no infrequent occurrence,—that the tides at times flow or ebb for four, five, six or even seven and eight hours*,—that frequent instances occur of retrograde movements for short periods of time, as if the tide had met with a check and been turned back; and at the turning-points there are numerous instances of the atmosphere being stationary for a couple of hours.

The maximum pressure of the atmosphere is in the coldest months, December or January, but the minimum pressure is not in the hottest months, but in June or July. The barometric readings, when protracted†, show a gradual curve from December or January descending to June or July, and then ascending again to December or January, there being an occasional interruption in October or November; and as the curves at Madras, Bombay and Calcutta correspond, and as Madras has NO S.W. monsoon, while Bombay has a S.W. monsoon, and as Bombay is destitute of the N.E. monsoon of Madras, it would appear that the general movements of the mass of the atmosphere are little influenced by any conditions of its lower strata; but the curve of pressure would seem to have some relation to the sun's place in the ecliptic.

The normal conditions of daily temperature are, that it is coldest in India at sunrise, and hottest between the hours of 1 and 3 P.M.; but the preceding tables show many aberrations from this rule. The regular increment or decrement of mean monthly heat from the maximum or minimum period is somewhat remarkable, as the curve is independent of the S.W. monsoon at Bombay and the N.E. monsoon at Ma-

* One instance at Aden of nine hours!

† To that very able and zealous meteorologist, Dr. BUIST, LL.D. of Bombay, I am indebted for the protracted curves of pressure of the barometer appended to this paper. Plates XVII. XVIII. XIX. XX.

dras; and the passage of the sun twice over both places does not derange the curve. The anomalies of the annual mean temperatures of Madras, Bombay, Calcutta and Aden, not diminishing with the increase in the latitude of the respective places, are pointed out, and numerous instances are given of the very great power of the slanting rays of the sun beyond the tropic. As is the case with the barometric, so do the heat tables indicate that the annual and daily ranges of the thermometer diminish with the elevation of the place of observation above the sea-level, the elevated table-land of the Deccan however being an exception to this rule. At Mahabuleshwur, at 4500 feet, the temperature of *the air* was never below 45° with a maximum and minimum thermometer; and at Dodabetta the temperature of *the air* was never below 38°·5; nevertheless at both places ice and hoar-frost were frequently found on the ground at sunrise, resulting from the separate or conjoined effects of radiation and evaporation. I have already stated that I do not attach much value to the readings of the wet bulb, owing to the various sources of error in the instrument itself, and to the manifest sources of error in the existing theoretical formulæ for giving a numerical value to its readings to fix the tension of vapour in the atmosphere for the determination of the dew-point. No doubt the dew-points obtained by means of the wet bulb have a certain relation to the truth; and in some favourably concurring conditions may be as proximate to the truth as dew-points would be, obtained by direct means; but the elaborate experiments of REGNAULT show that in a calm in the open air or in a chamber, the wet bulb surrounds itself with its own humid atmosphere, and with a breeze blowing upon it the temperature of the wet bulb falls or alternates as the wind blows more or less rapidly upon it. Moreover, Professor ORLEBAR points out a source of error to which no doubt all the observations in India were more or less subject, namely, the proximity of the dry bulb to the wet bulb, and the cold from the latter in consequence depressing the temperature of the dry bulb, two, three, or more degrees below the temperature of the air, necessarily producing fallacious results. Making allowance for the defects of DANIELL's hygrometer, the dew-points obtained by its means are infinitely more worthy of confidence than those obtained by means of the wet bulb. On the whole, I would not venture to say more with respect to normal conditions of moisture in India, than that the air of the sea-coast has always a much greater fraction of saturation than the lands of the interior, and that the elevated plateau of the Deccan is periodically subject to very great degrees of dryness.

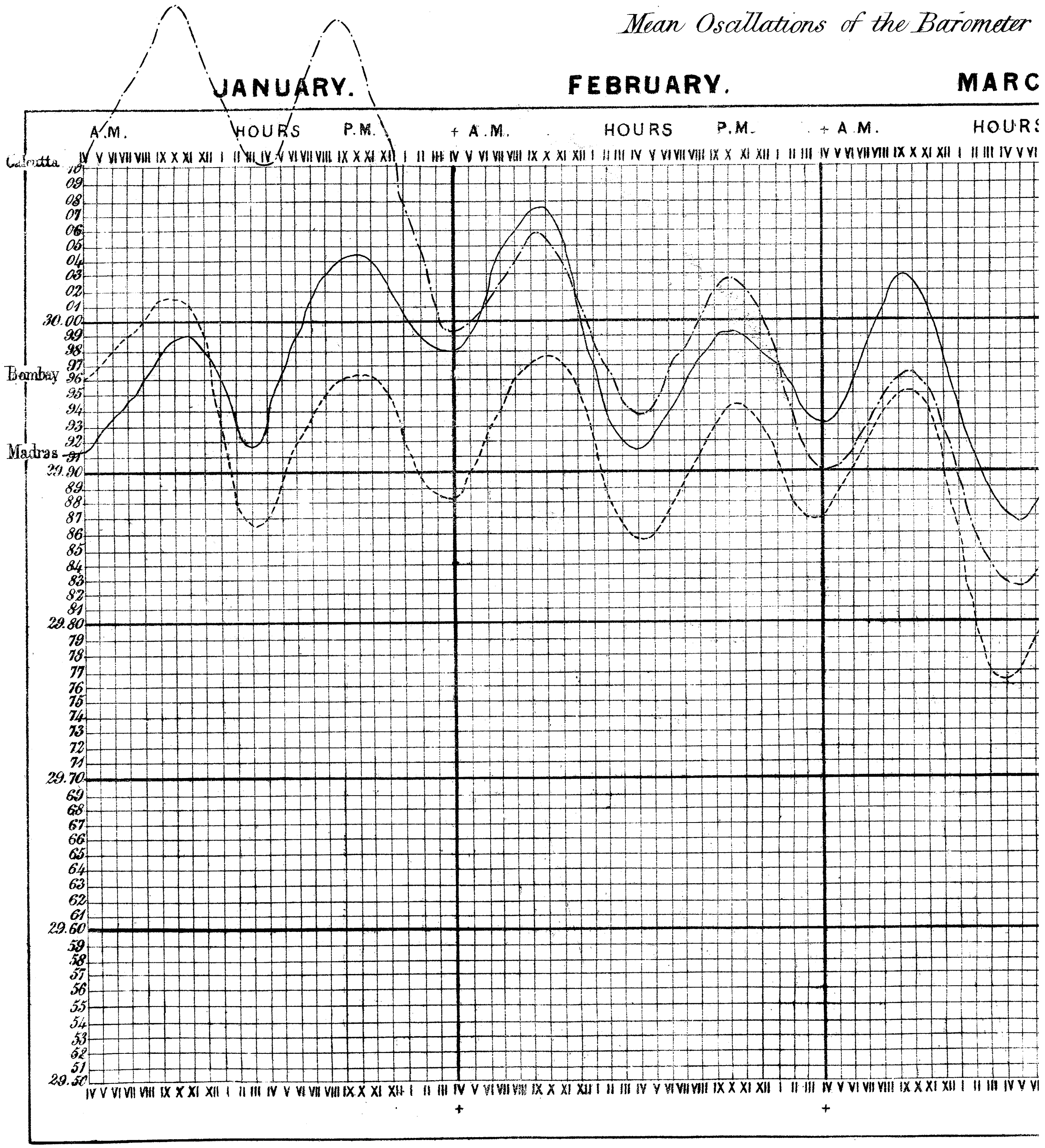
The rain-tables are so extensive that it will only be necessary to point out some unexpected phenomena connected with the distribution of rain. It is found both on the sea-coasts and on the table-lands of the Deccan, that within very limited areas, the differences in the fall of rain may be very great. With nine rain-gauges employed in the small island of Bombay in the months of June and July, in the monsoon of 1849, the quantity collected in the different gauges ranged in July from 46 inches to 102 inches, and in June from 19 inches to 46 inches. At Sattarah, with three rain-

gauges within the distance of a mile, they differed in their contents several inches from each other; and at Mahabuleshwur and Paunchgunny, nearly on the same level, the latter place being only eleven miles to the eastward of the former, the difference in the annual fall of rain was respectively 254 inches and 50 inches! The normal conditions are, that there is a much greater fall of rain on the sea-coasts than on the table-lands of the Deccan, but that the Ghâts intervening between the coasts and the table-lands have three times the amount of the fall on the coasts, and from ten to fifteen times the amount of the fall on the table-lands of the interior; the paucity of the fall of rain at Cape Comorin and in the mouths of the Indus would also appear to be normal conditions.

The Tables must be referred to for the winds; the normal states are those of the S.W. and N.E. monsoons, and the influence of the latter is periodically felt at the height of 8640 feet, which height would appear just at the upper surface of the stratum of air constituting the S.W. monsoon; but hourly observations for lengthened periods of time are necessary from Dodabetta, to determine what really are the periodical winds at that height. From the points other than those between S. and W., and N. and E., there is also at the several stations a certain amount of periodicity in the winds; the winds that are common to different stations having only a slant more or less at the different stations; for instance, the S.W. and N.W. winds of Bombay blowing in the summer months in Calcutta incline rather to be S. and N. winds, than S.W. and N.W. winds; but to be enabled to speak with any precision upon this branch of the meteorology of India, and indeed upon most other branches with a comprehensive and philosophical object, hourly observations are necessary,—simultaneously taken with previously compared instruments by zealous observers; and having the records in a form common to all the observers, so as to admit of rigid comparisons:—when this is done, not only in India but in Europe, meteorologists will be in a better condition to generalize and propound normal conditions, than the state of our knowledge at present would justify, for it must be borne in mind that "Error latet in generalibus."

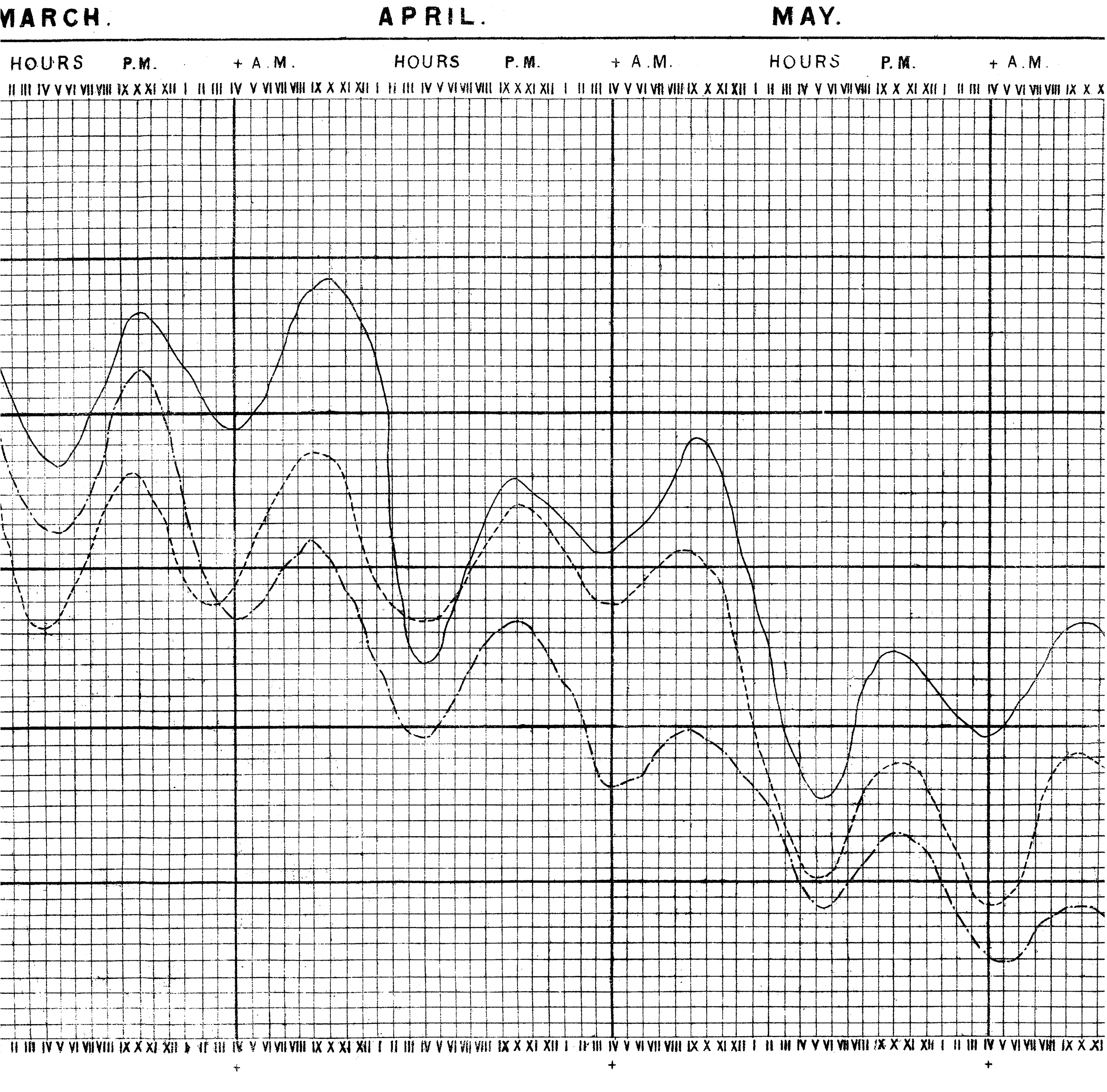
The Plates referred to in the preceding paper are numbered XVII. XVIII. XIX. XX.

Mean Oscillations of the Barometer



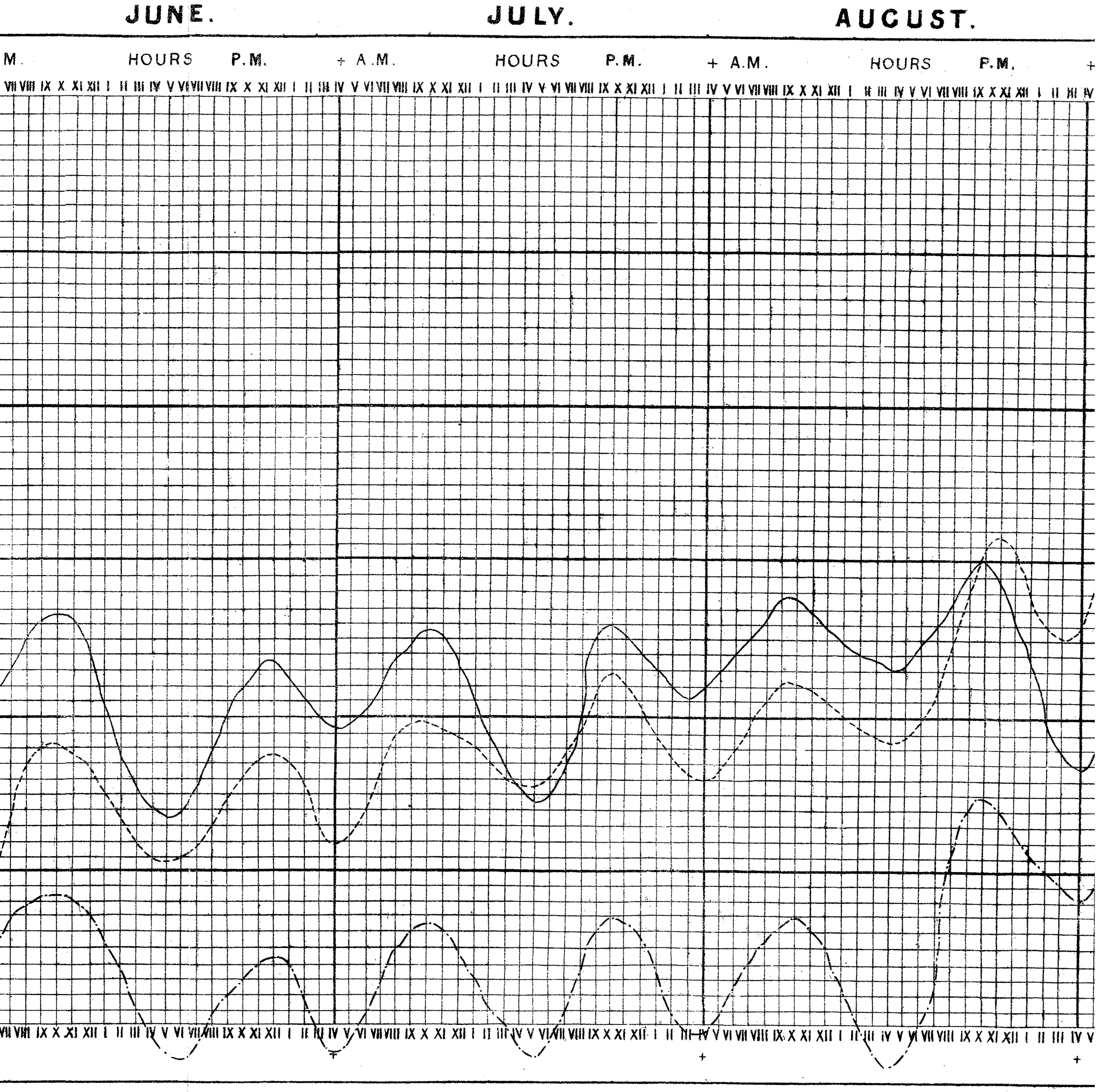
N.B. These Barometric Curves represent 1st the mean daily oscillations of the barometer for
For example – At Bombay in 1845, the mean maximum daily pressure in Jan.y was betw
mean maximum night pressure was between 10 and 11 p.m. and the mean minimum n
from 30°.015 to 29°.865. – Similarly in the monsoon months of June, July & August
the mean range of the Barometer in June is from 29.683 to 29.607.

ometer corrected for Temperature at Calcutta, Bombay and Madras.



ter for each month of the year. _ 2ndly The mean monthly pressure for each month in the year. _
as between 9 and 10 a.m. _ The mean minimum daily pressure was between 3 and 4 p.m. The
imum night pressure was between 3 and 4 a.m. _ The mean monthly range of the barometer was
lugust the horary oscillations or atmospheric tides continue at the same hours as in January, but

1845.



... year. — 3rdly The Annual curve of pressure.
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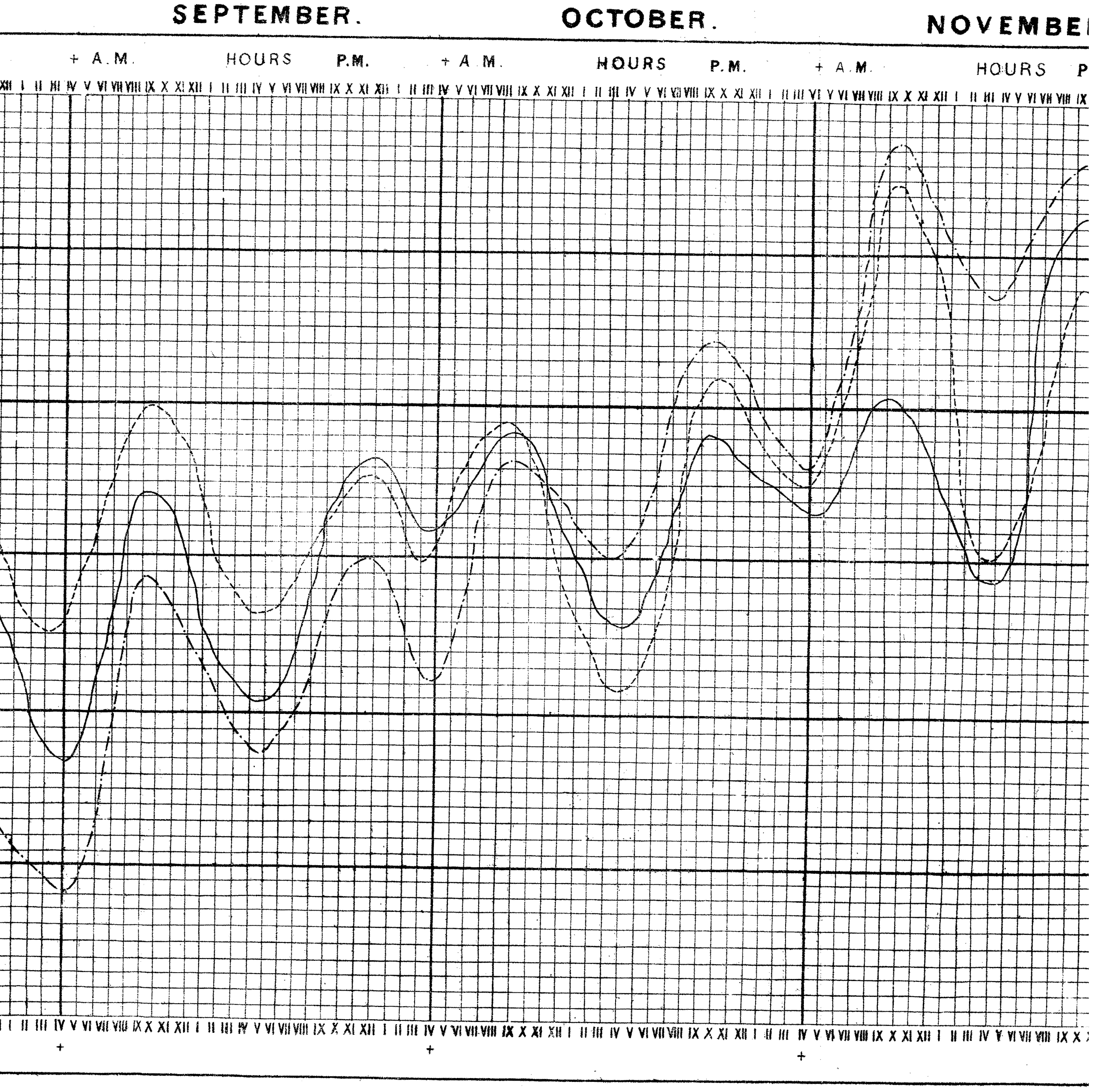
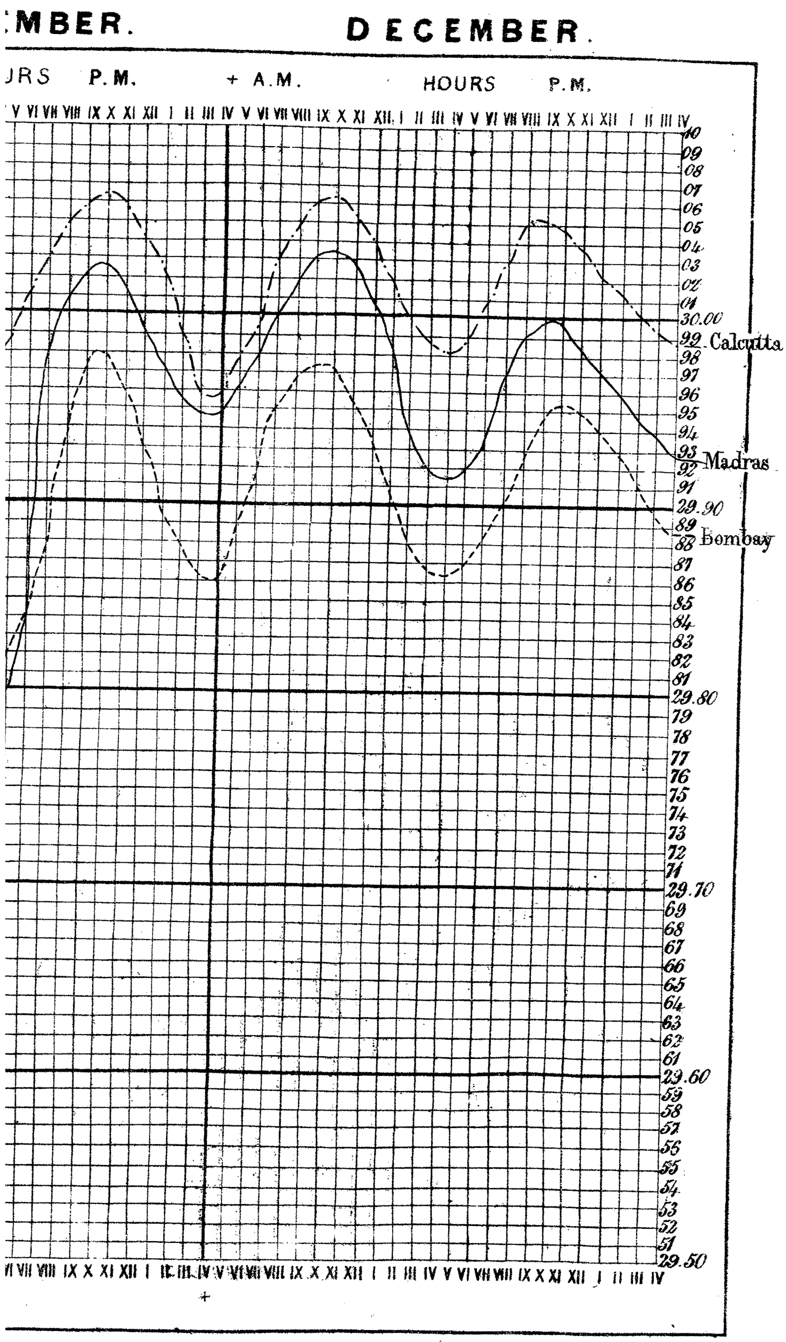
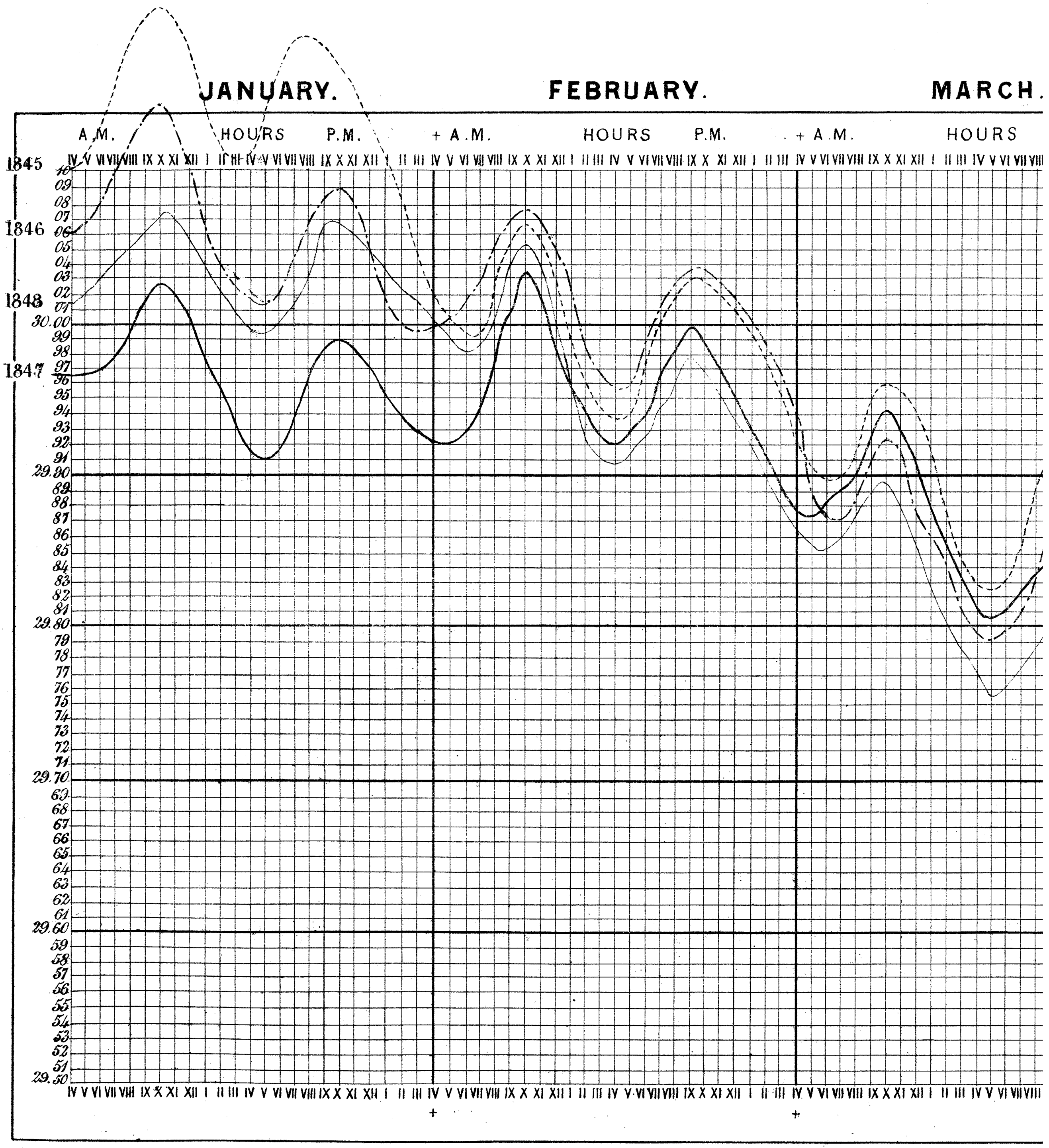
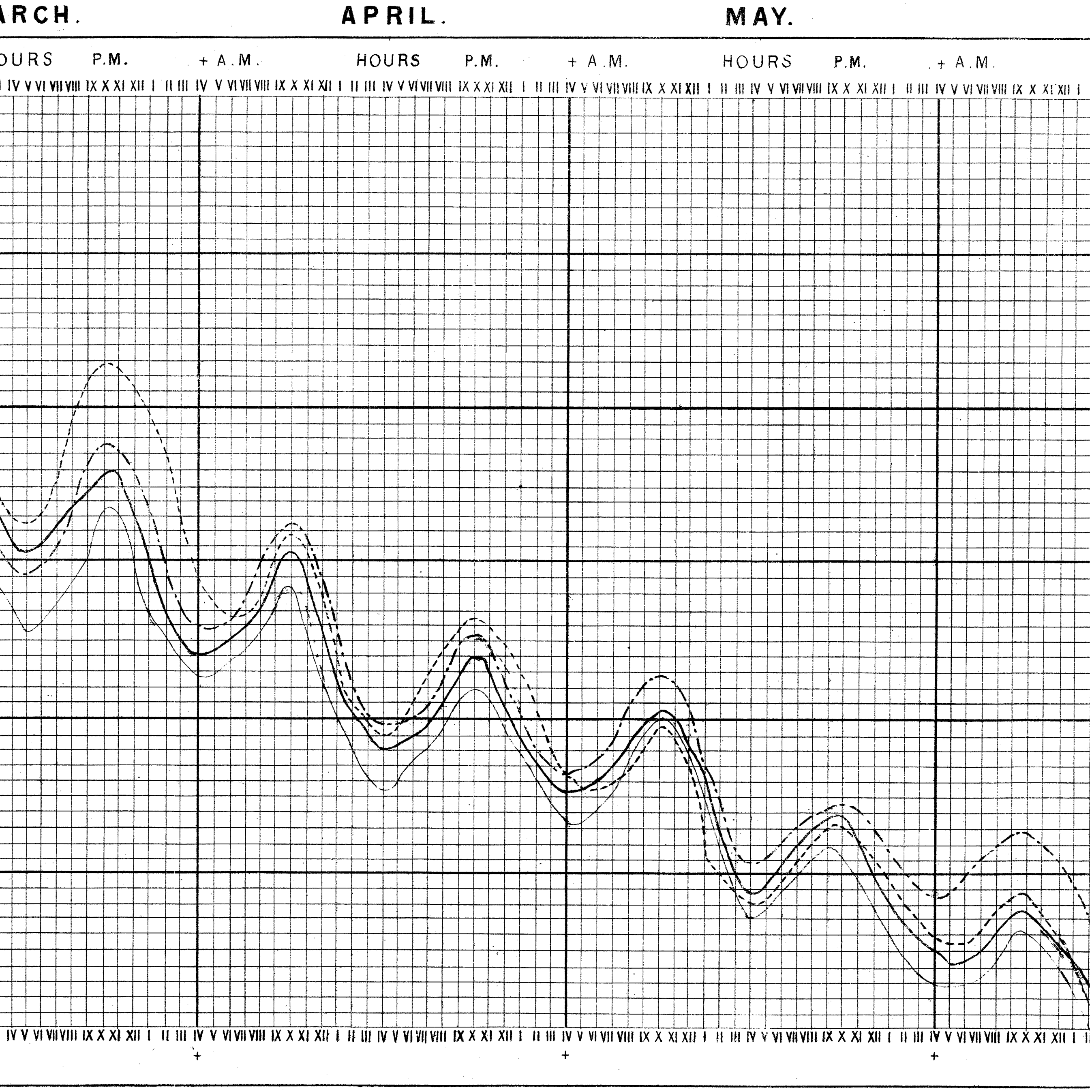

SEPTEMBER.
OCTOBER.
NOVEMBE
+ A.M.
HOURS
P.M.



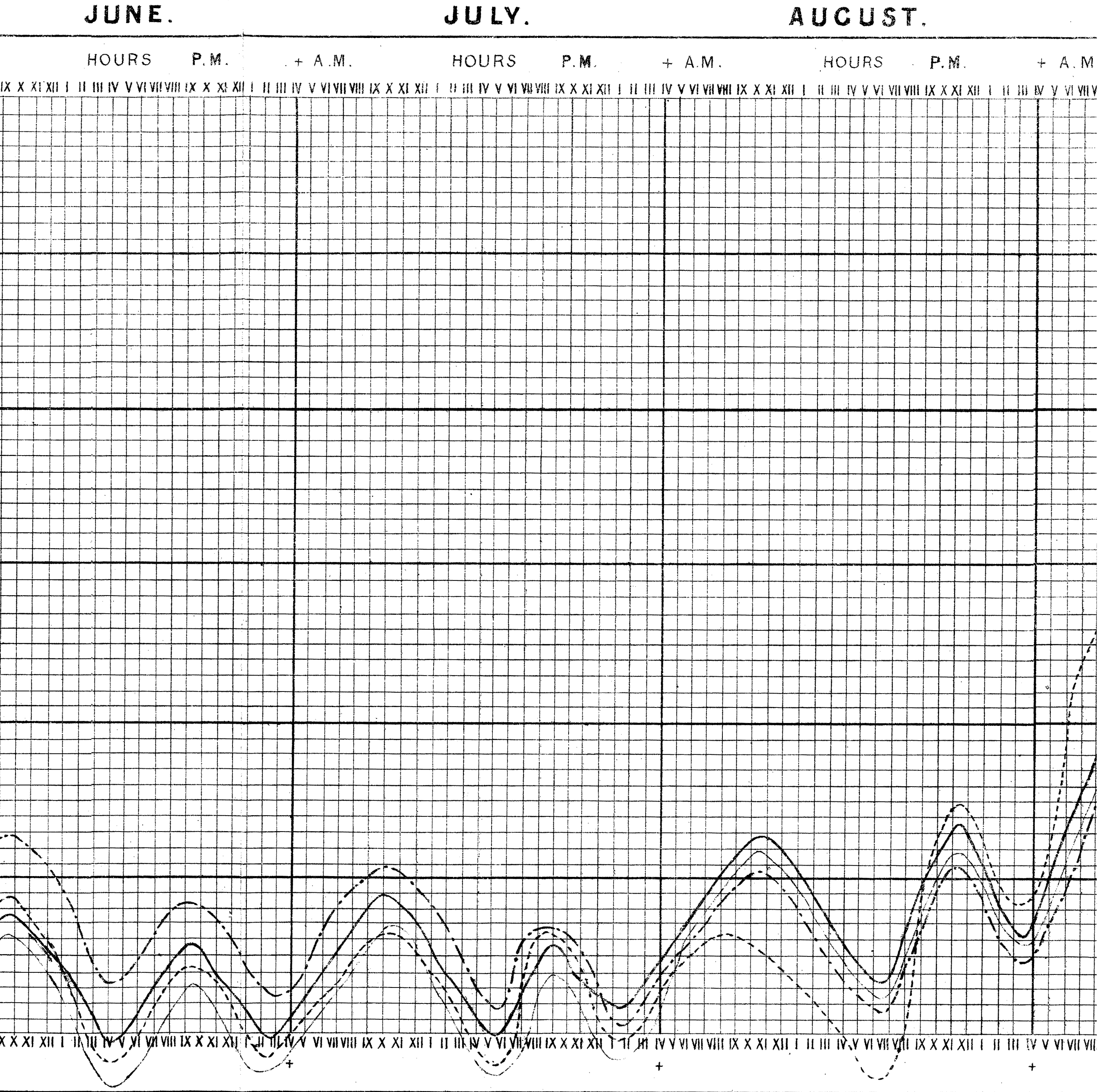
MBER.
DECEMBER.
URS P.M.
+ A.M.
HOURS P.M.
30.00
29.90
29.80
29.70
29.60
29.50
Calcutta
Madras
Bombay


JANUARY.
FEBRUARY.
MARCH.
A.M.
HOURS
P.M.
+ A.M.
HOURS
P.M.
+ A.M.
HOURS
1845
1846
1848
1847
30.00
29.90
29.80
29.70
29.60
29.50
IV V VI VII VIII IX X XI XII I II III IV V VI VII VIII IX X XI XII I II III IV V VI VII VIII IX X XI XII I II III IV V VI VII VIII IX X XI XII I II III IV V VI VII VIII IX X XI XII I II III IV V VI VII VIII
+
+

Mean horary oscillation of the Barometer at

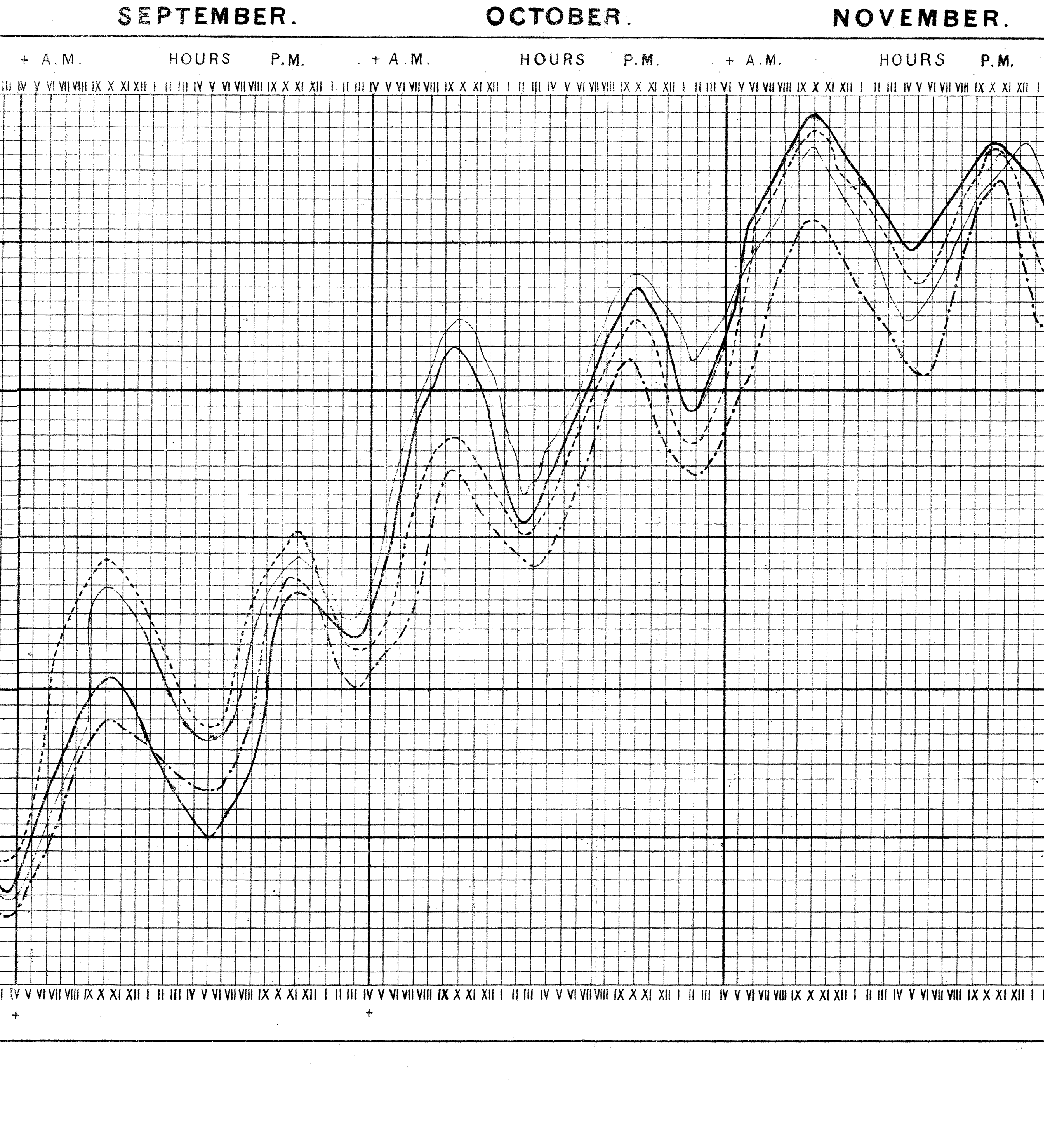


at CALCUTTA for the years 1845, 1846, 1847 and 1848.



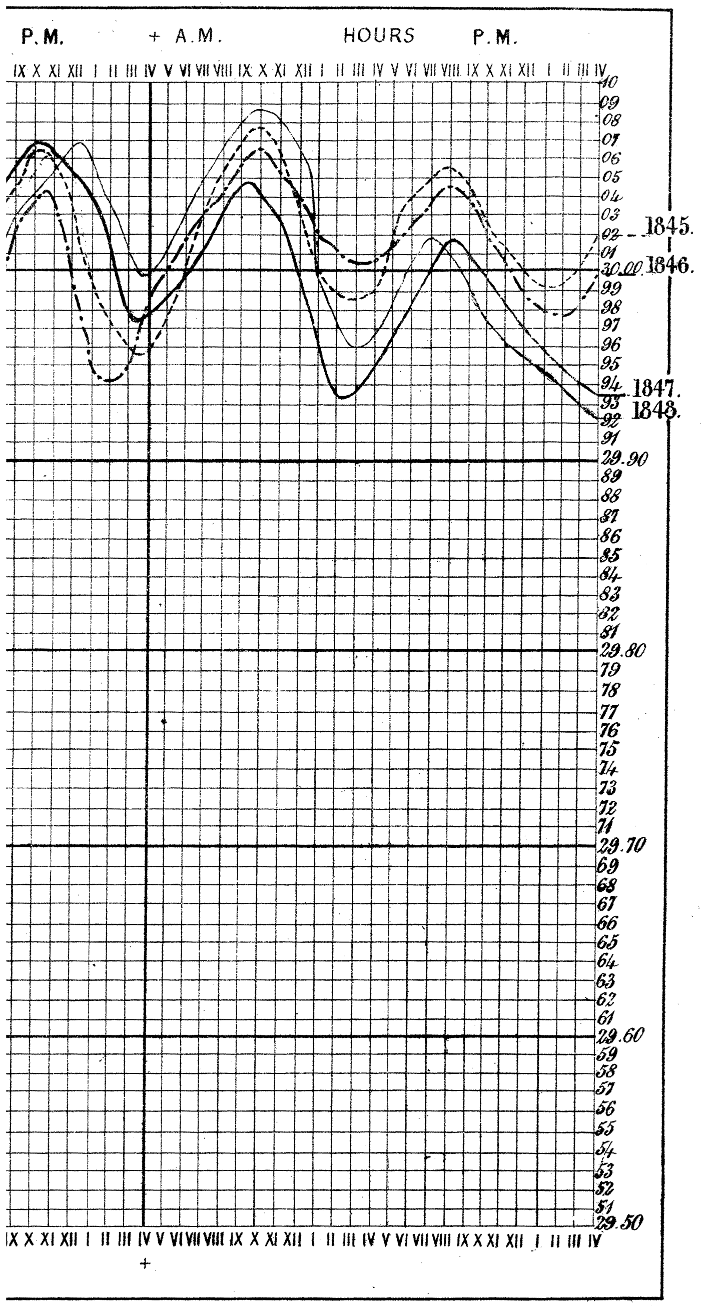
Phil

1848.

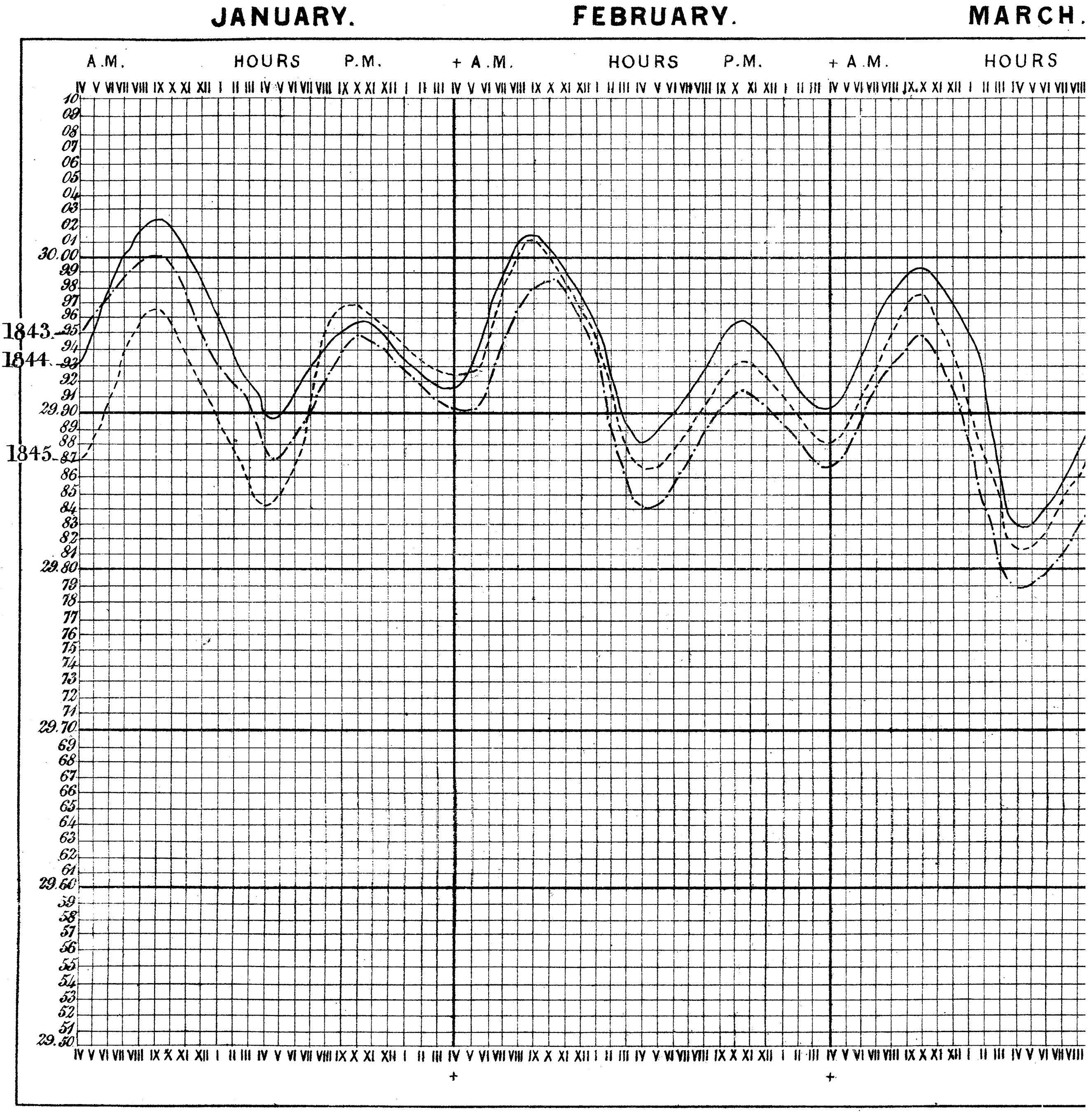


SEPTEMBER.
OCTOBER.
NOVEMBER.
+ A.M.
HOURS
P.M.
+ A.M.
HOURS
P.M.
+ A.M.
HOURS
P.M.

ER. DECEMBER.



J. Basire, lith.


JANUARY.
FEBRUARY.
MARCH.
A.M.
HOURS
P.M.
+ A.M.
HOURS
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+ A.M.
HOURS
1843.
1844.
1845.
30.00
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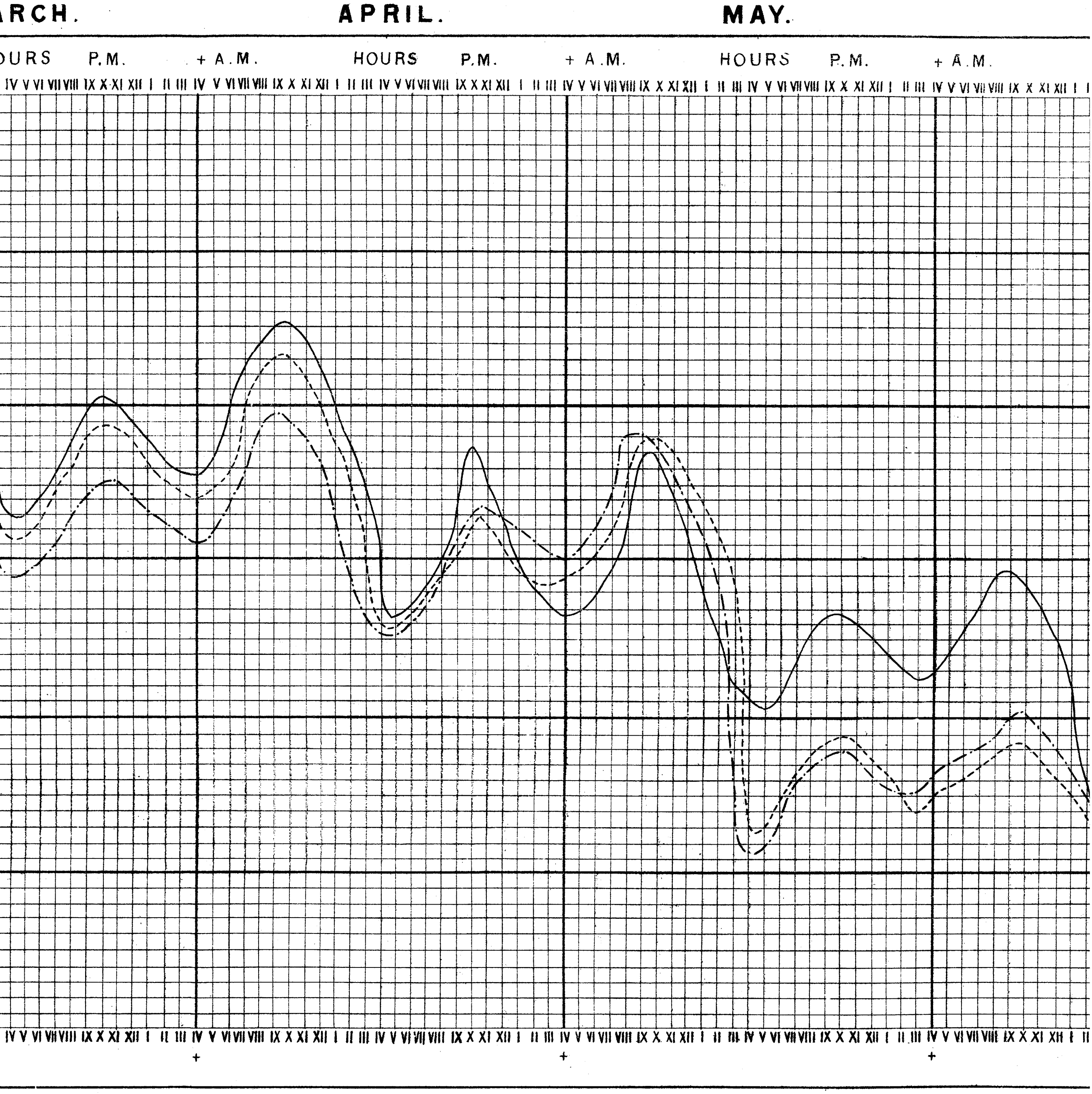
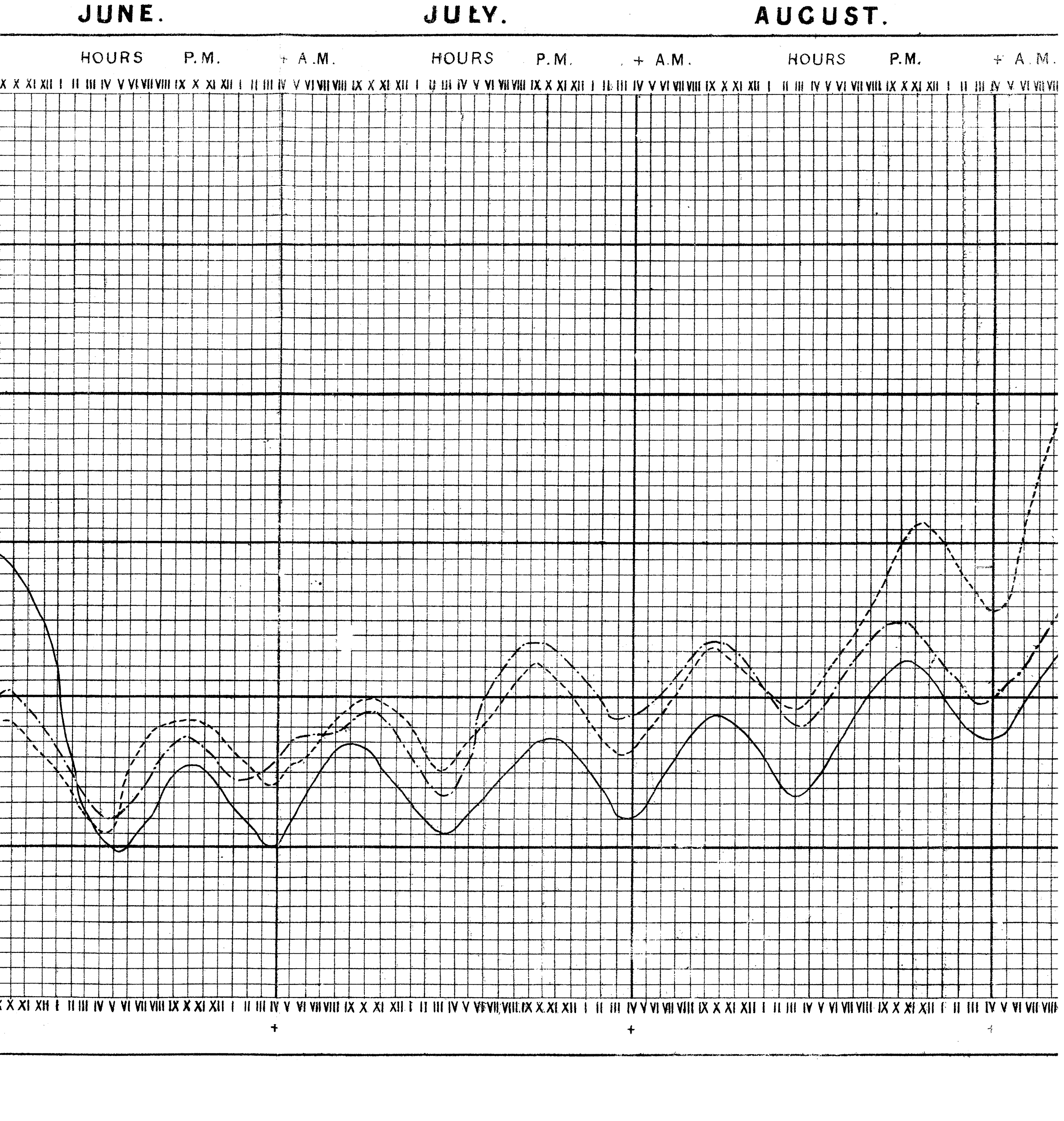
29.80
29.70
29.60
29.50

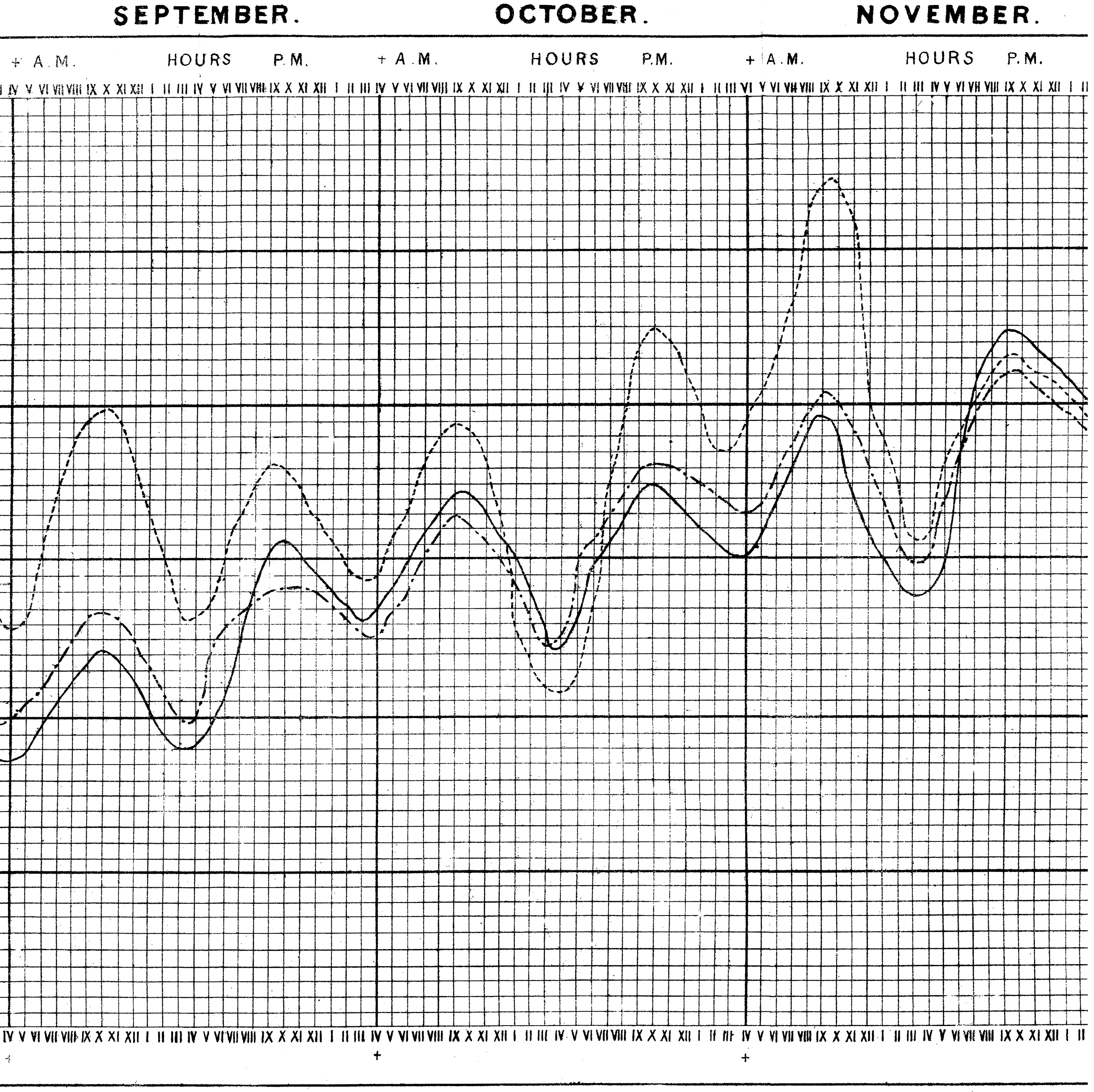
Mean horary oscillation of the Barometer at

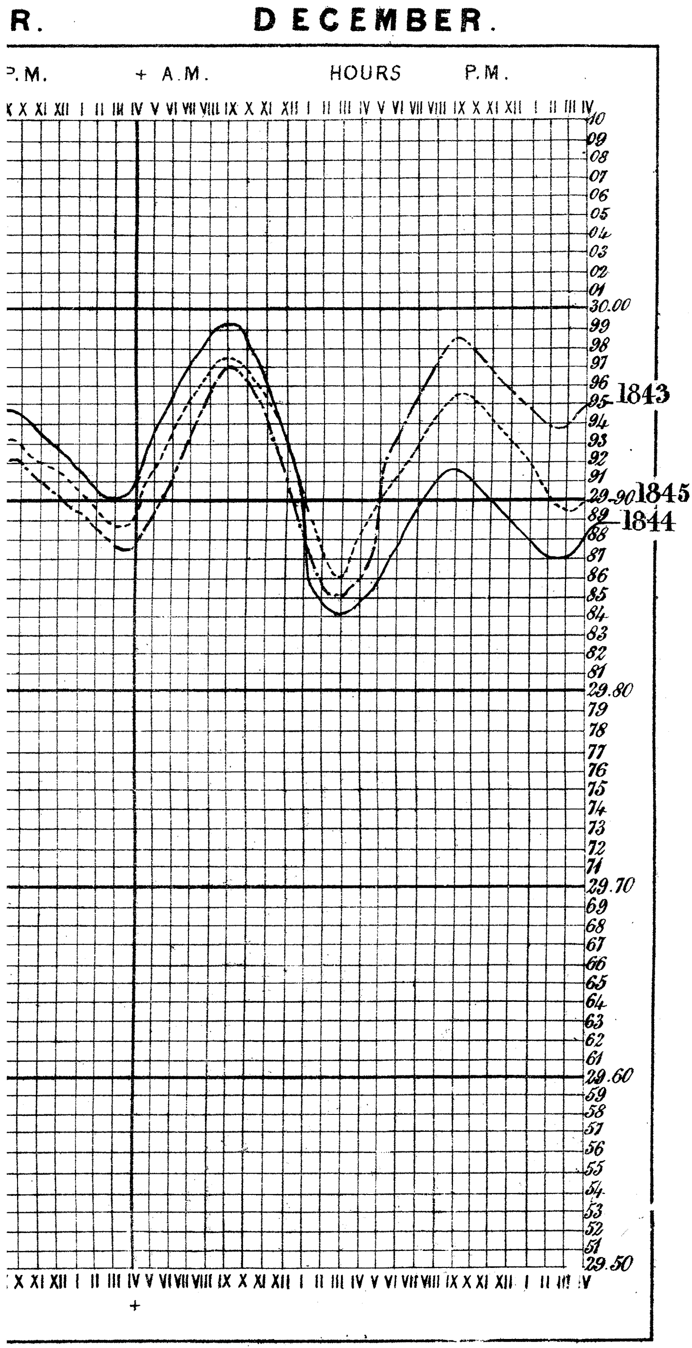


r at **BOMBAY**, *for the years 1843, 1844 & 1845.*

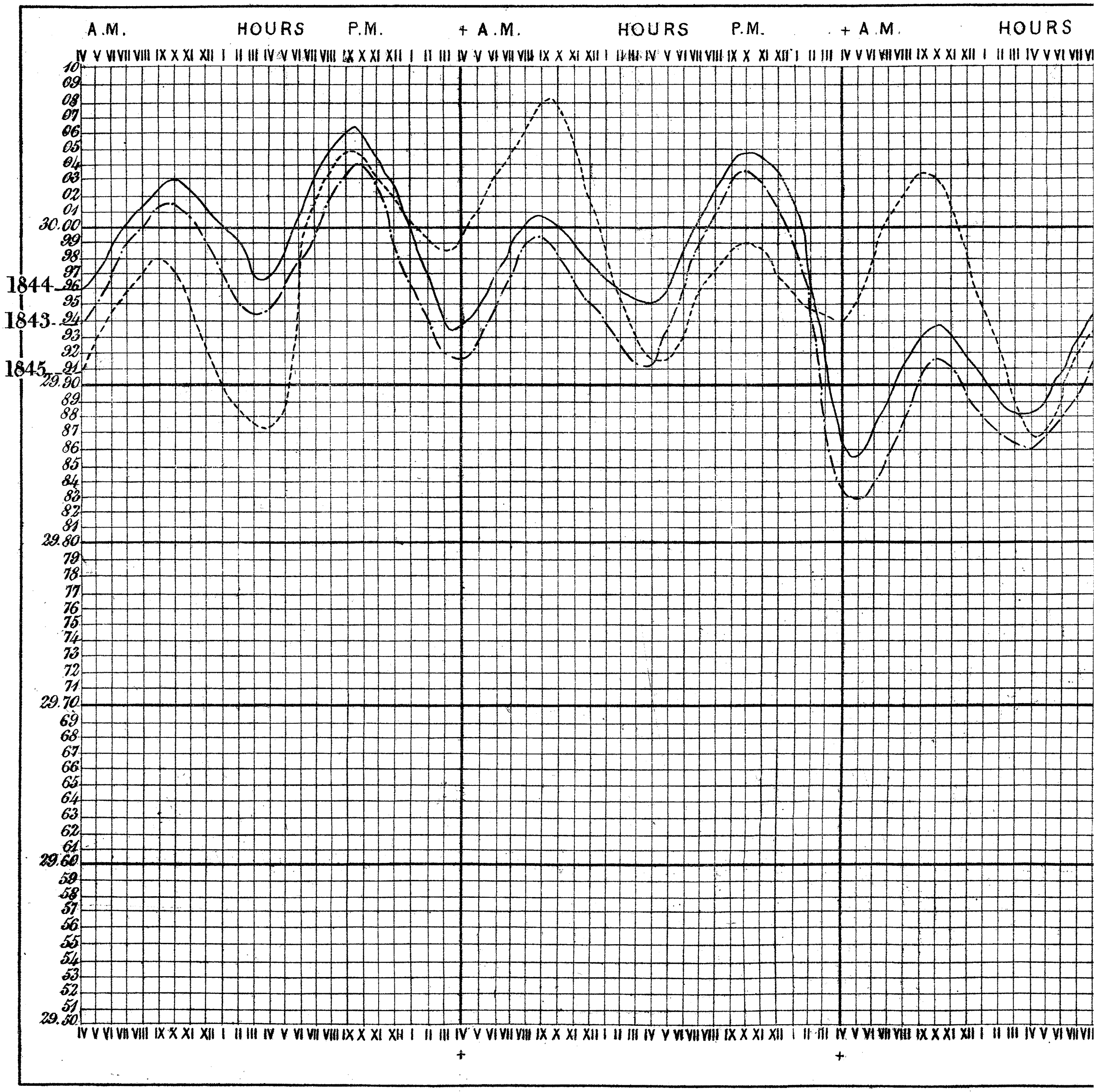


5.

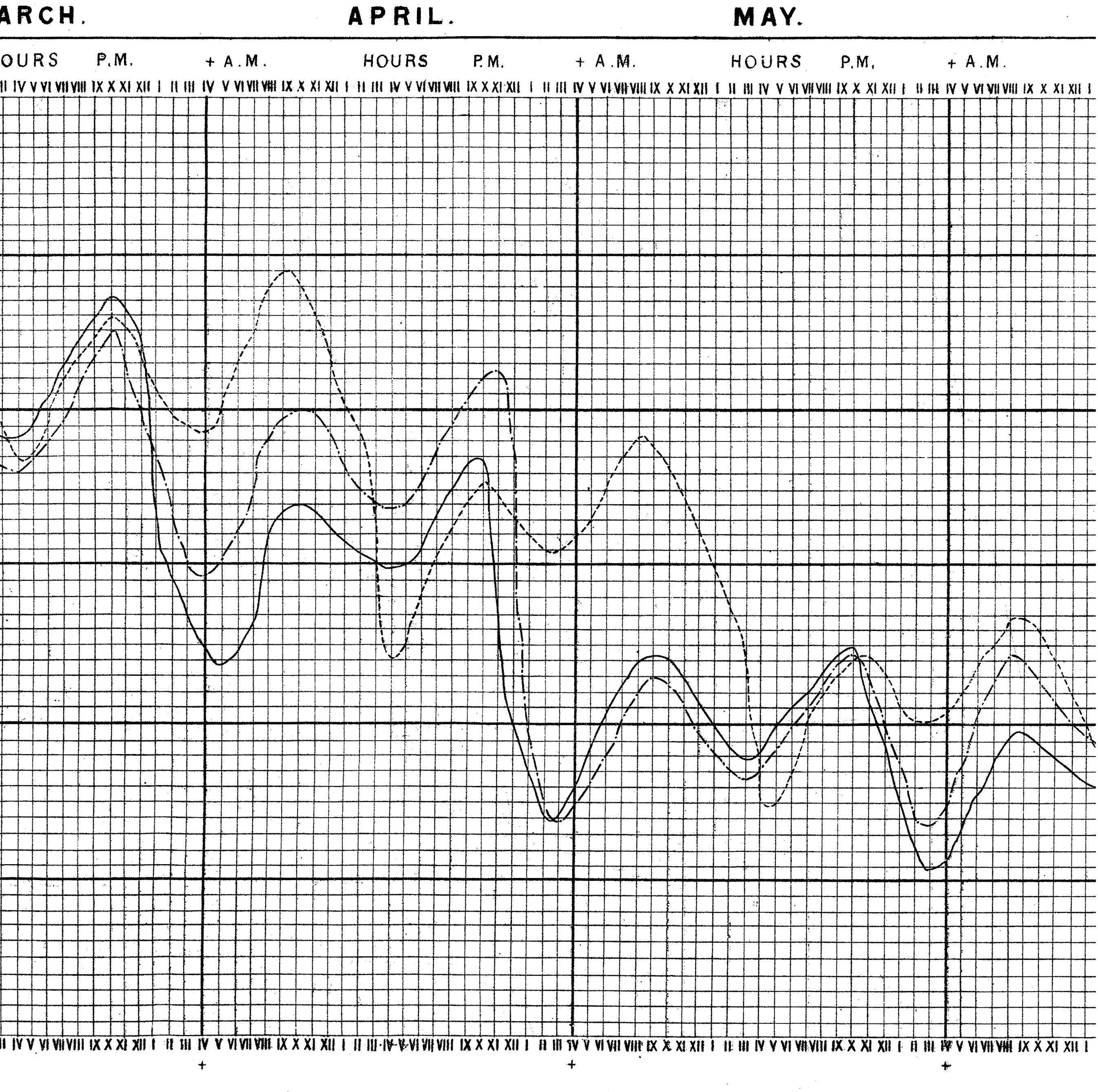

SEPTEMBER.
OCTOBER.
NOVEMBER.
+ A.M.
HOURS
P.M.
+ A.M.
HOURS
P.M.
+ A.M.
HOURS
P.M.


R.
DECEMBER.
P.M.
+ A.M.
HOURS
P.M.
30.00
29.90
29.80
29.70
29.60
29.50
1843
1845
1844

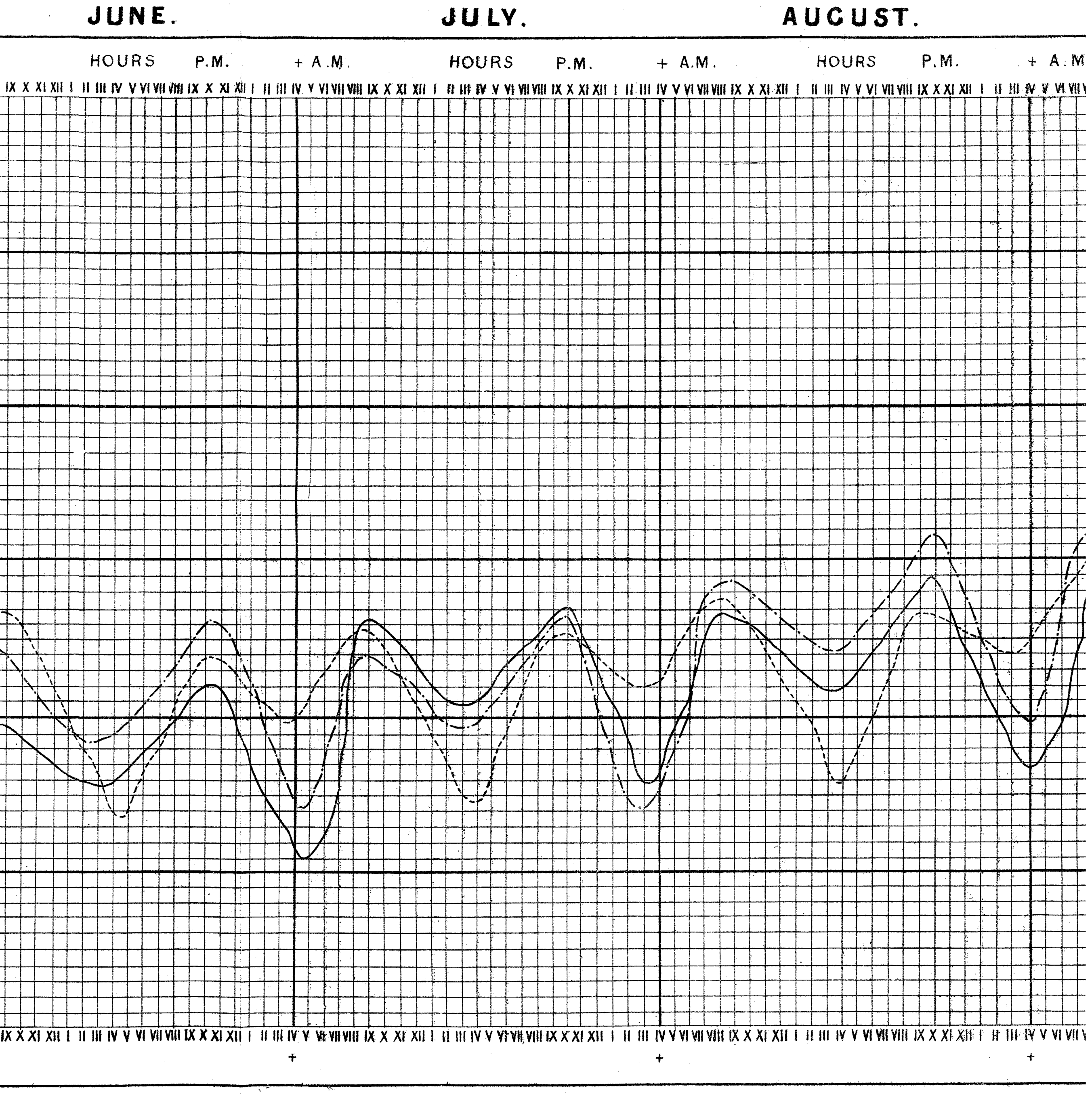
JANUARY. FEBRUARY. MARCH

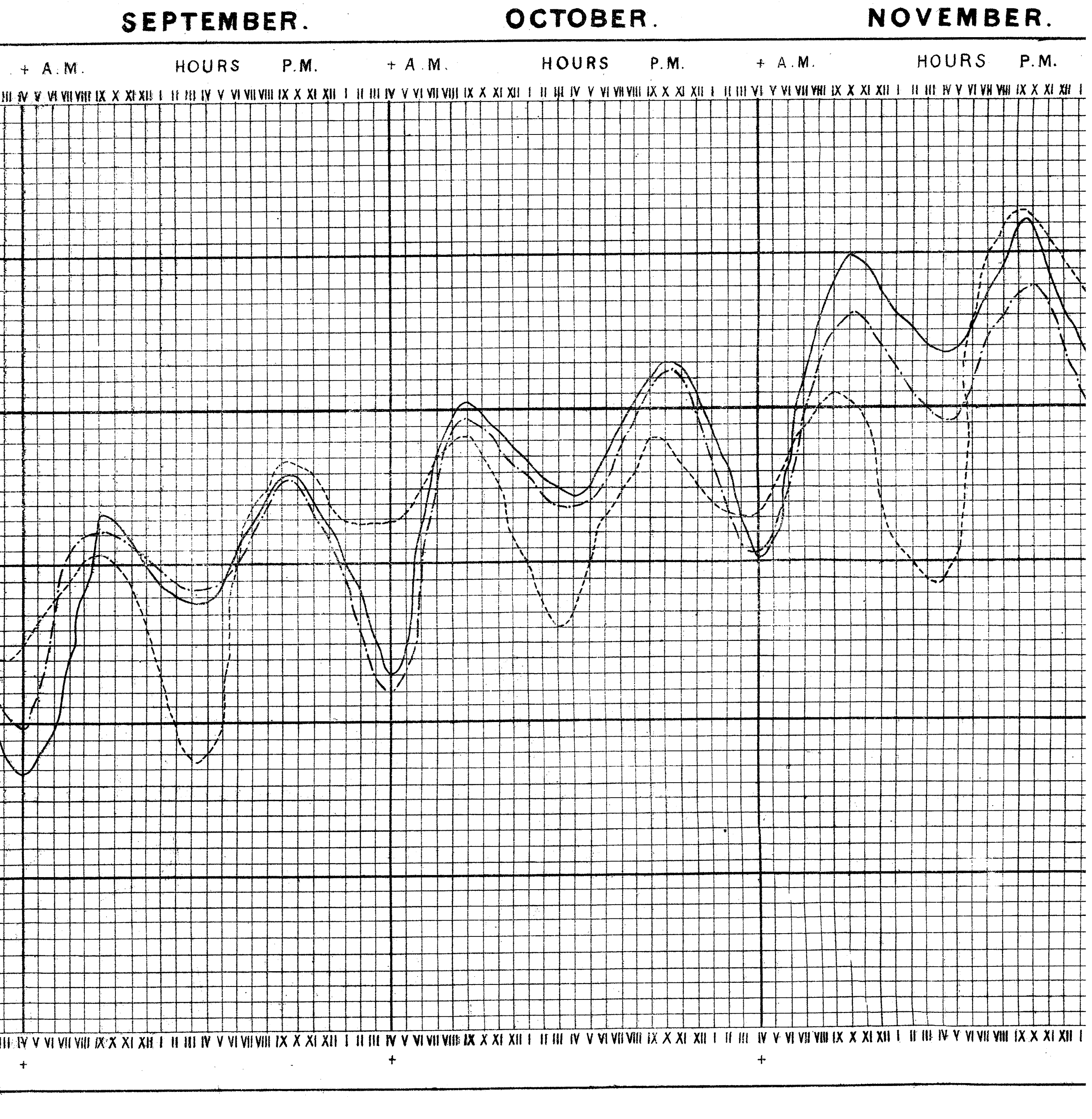


Mean horary oscillation of the Barometer

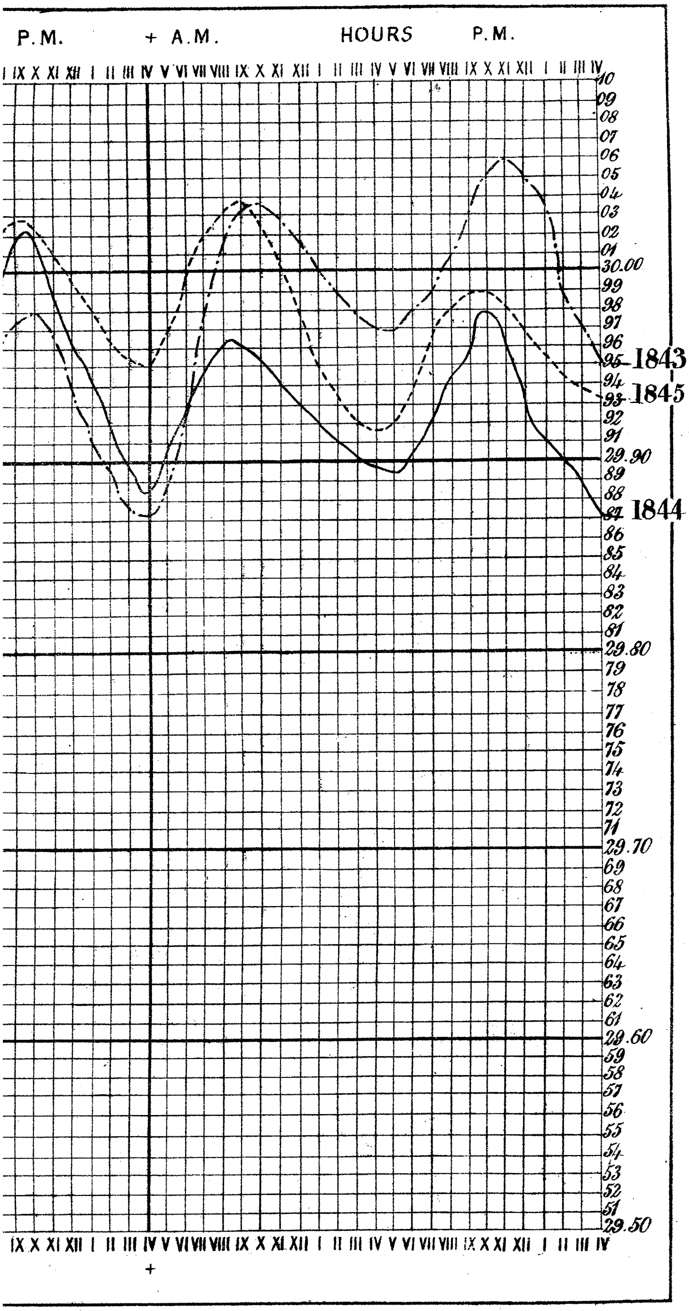


...meter at MADRAS, for the years 1843, 1844 and 1845.




SEPTEMBER.
OCTOBER.
NOVEMBER.
+ A.M.
HOURS
P.M.

ER. DECEMBER.



P.M.
+ A.M.
HOURS
P.M.
I IX X XI XII I II III IV V VI VII VIII IX X XI XII I II III IV V VI VII VIII IX X XI XII I II III IV
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29.50
1843
1845
1844
IX X XI XII I II III IV V VI VII VIII IX X XI XII I II III IV V VI VII VIII IX X XI XII I II III IV
+

Range of Thermometer and Hours of occasional Minima and Maxima.

	Madras, 1842. Minimum. Therm.	Hour. A.M. (h m)	Date.	Maximum. Therm.	Hour. P.M. (h m)	Date.	Range.	Madras, 1843. Minimum. Therm.	Hour. A.M. (h m)	Date.	Maximum. Therm.	Hour. P.M. (h m)	Date.	Range.
January	69°·5	6 41	6	85°·1	1 41	27	15°·6	70°·5	5 41	5	83°·0	0 41	4	12°·5
February......	67·2	5 41	17	88·0	2 41	28	20·8	69·2	6 41	9	85·4	0 41	19	16·2
March.........	72·4	6 41	10	92·0	1 41	20	19·6	74·1	3 41	16	89·8	0 41	26	15·7
April	74·5	5 41	1	96·5	0 41	20	22·0	78·5	4 41	9	93·3	1 41	30	14·8
May	81·1	2 41	1	100·8	2 41	31	19·7	76·2	5 41	23	93·8	A.M. 11 41	1	17·6
June	78·8	5 41	12	100·2	2 41	21	21·4	78·7	3 41	14	95·4	1 41	9	16·7
July	79·1	5 41	5	98·6	1 41	10	19·5	78·7	5 41	31	95·5	2 41	21	16·8
August	75·6	6 41	19	94·8	2 41	1	19·2	78·2	5 41	28	95·3	1 41	7	17·1
September ...	75·7	6 41	12	92·5	1 41	6	16·8	76·9	6 41	28	95·3	2 41	1	18·4
October	74·2	5 41	25	90·5	2 41	3	16·3	72·9	5 41	23	87·5	2 41	23	14·7
November ...	71·0	5 41	21	84·6	1 41	2	13·6	69·4	5 41	29	85·2	0 41	1	15·8
December ...	68·5	6 41	12	82·8	1 41	25	14·3	68·0	5 41	31	82·5	1 41	8	14·5
Year	67·2	5 41	...	100·8	2 41	...	33·6	68·0	5 41	...	95·5	2 41	...	27·0

	Madras, 1844. Minimum. Therm.	Hour. A.M. (h m)	Date.	Maximum. Therm.	Hour. P.M. (h m)	Date.	Range.	Madras, 1845. Minimum. Therm.	Hour. A.M. (h m)	Date.	Maximum. Therm.	Hour. P.M. (h m)	Date.	Range.
January	66°·2	6 41	24	82°·8	0 41	27	16°·6	68°·2	6 41	23	84°·3	2 41	30	16°·1
February......	67·7	5 41	19	87·2	1 41	26	19·5	71·8	5 41	28	86·0	1 41	21	14·2
March.........	72·0	6 41	10	90·7	1 41	25	18·7	73·6	5 41	7	92·3	0 41	30	18·7
April	77·2	5 41	8	99·0	0 41	3	21·8	78·5	6 41	30	94·0	0 41	11	15·5
May	77·4	7 41	14	103·3	1 41	5	25·9	78·8	4 41	6	104·4	0 41	12	25·6
June	80·3	3 41	16	103·2	1 41	11	22·9	78·8	2 41	18	101·0	1 41	6	22·2
July	77·8	0 41	21	96·2	2 41	8	18·4	79·3	5 41	20	97·7	2 41	10	18·4
August	78·1	0 41	6	95·3	1 41	23	17·2	79·0	5 41	19	97·1	1 41	28	18·0
September ...	75·4	2 41	18	94·7	2 41	9	19·3	76·2	5 41	16	94·8	0 41	2	18·6
October	73·5	5 41	24	88·5	2 41	25	15·0	75·3	5 41	27	91·5	0 41	3	16·2
November ...	70·9	5 41	19	86·0	A.M. 11 41	8	15·1	70·3	5 41	26	88·2	A.M. 11 41	6	17·9
December ...	69·6	6 41	3	83·5	0 41	2	13·9	70·0	5 41	18	83·5	11 41	10	13·5
Year	66·2	6 41	...	103·3	1 41	...	37·1	68·2	6 41	...	104·4	0 41	...	36·2

	Bombay, 1843. Minimum. Therm.	Hour. A.M. (h)	Date.	Maximum. Therm.	Hour. P.M. (h)	Date.	Range.	Bombay, 1844. Minimum. Therm.	Hour. A.M. (h)	Date.	Maximum. Therm.	Hour. P.M. (h)	Date.	Range.
January	65°·9	8	4	85°·2	3	31	19°·3	66°·0	6	12	83°·9	1	13	17°·9
February......	70·9	7	18	85·6	2	2	14·7	64·7	7	9	85·4	3	14	20·7
March.........	73·0	7	2	88·2	1	31	15·2	70·4	6	3	87·0	1	29	16·6
April	79·0	6	3	90·0	1	29	11·0	77·3	6	2	90·2	2	21	12·9
May	80·9	6	4	90·3	2	1	9·4	81·9	5	10	91·9	2	27	10·0
June	80·5	6	19	90·0	2	10	9·5	78·0	4	30	90·8	2	13	12·8
July	78·3	7	15	88·1	2	1	9·8	78·0	5	22	87·2	2	2	9·2
August	77·5	7	22	85·9	12*	11	8·4	77·0	Midnight	28	85·5	2	26	8·5
September ...	76·4	6	29	87·6	2	23	11·2	75·4	4	14	86·1	3	29	10·7
October	77·0	5	24	87·8	3	21	10·8	75·3	5	28	90·5	1	4	15·2
November ...	76·5	6	30	88·0	3	6	16·5	73·9	6	21	90·9	2	3	19·0
December ...	68·4	7	20	85·9	12*	6	17·5	69·8	7	9	87·8	1	19	18·0
Year	65·9	8	...	90·3	2	...	24·4	64·7	7	...	91·9	2	...	27·2

	Aden, 1848. Min.	Max.	Range.	Calcutta, 1848–49. Min.	Max.	Range.	
January	68°·5	76°·7	8°·2	57°·5	78°·5	21°·0	January.
February......	69·0	77·8	8·8	64·6	83·5	19·9	February.
March.........	71·6	82·0	10·4	72·0	93·7	21·5	March.
April	75·5	85·8	10·3	79·4	99·4	20·0	April.
May	80·6	89·0	8·4	79·6	97·8	18·2	May.
June	82·5	88·5	6·0	81·1	92·8	11·7	June.
July	80·4	86·4	6·0	81·4	91·8	10·4	July.
August	78·4	84·6	6·2	80·8	90·2	9·4	August.
September ...	81·6	88·2	6·6	80·7	92·4	11·7	September.
October	77·8	89·0	11·2	75·8	89·1	14·3	October.
November ...	73·7	83·1	9·4	68·3	84·9	16·6	November.
December ...	75·0	81·6	6·6	68·8	82·4	18·6	December.
Year	68·5	89·0	20·5	57·5	99·4	41·9	Year.

[Lieut.-Colonel SYKES's Discussion of the Meteorological Observations taken in India.]

* Noon.

Months.	Madras. 1843. Thermometer, dry.	Madras. 1843. Thermometer, wet.	Madras. 1843. Elastic force.	Madras. 1843. Per-centage of vapour.	Madras. 1844. Thermometer, dry.	Madras. 1844. Thermometer, wet.	Madras. 1844. Elastic force.	Madras. 1844. Per-centage of vapour.	Bombay. 1843. Thermometer, dry.	Bombay. 1843. Thermometer, wet.	Bombay. 1843. Elastic force.	Bombay. 1843. Per-centage of vapour.	Bombay. 1844. Thermometer, dry.	Bombay. 1844. Thermometer, wet.	Bombay. 1844. Elastic force.	Bombay. 1844. Per-centage of vapour.
January	77°·59	72°·32	·726	79	75°·71	69°·57	·651	75	76°·3	68°·0	·598	69	75°·4	67°·5	·581	67
February ...	77·90	71·86	·705	76	77·74	71·45	·694	75	78·0	70·7	·645	68	73·3	68·6	·608	68
March	81·52	75·22	·791	76	82·20	75·51	·796	75	79·7	73·0	·726	73	79·5	73·4	·743	75
April	85·19	78·93	·899	77	86·34	79·73	·921	76	84·2	77·9	·867	76	84·1	78·1	·876	77
May	85·02	79·06	·908	78	86·98	79·98	·925	75	85·9	79·8	·927	77	85·9	78·8	·885	73
June	85·52	78·05	·860	73	88·58	78·82	·859	67	85·3	80·0	·943	79	85·3	79·9	·938	79
July	85·79	76·73	·803	67	85·76	77·86	·850	72	82·0	78·4	·912	85	81·9	79·0	·938	88
August	84·51	76·95	·826	72	85·25	77·94	·858	73	81·2	77·2	·872	84	81·6	78·0	·900	85
September ...	84·26	77·21	·839	74	82·97	77·37	·861	79	81·1	77·3	·876	84	80·7	77·0	·869	86
October	80·72	76·50	·851	83	80·53	75·86	·828	82	82·2	76·5	·832	77	83·5	78·0	·879	79
November ...	77·83	71·71	·702	76	79·17	72·41	·713	73	80·3	72·2	·690	68	80·8	72·1	·681	66
December ...	75·89	70·73	·691	79	76·94	72·90	·755	83	76·7	68·6	·603	67	79·6	71·6	·676	68
	81·81	75·44	·796	75	82·34	75·78	·803	74½	81·1	75·0	·736	76	81·2	75·1	·789	76

Months.	Calcutta. 1843. Thermometer, dry.	Calcutta. 1843. Thermometer, wet.	Calcutta. 1843. Elastic force.	Calcutta. 1843. Per-centage of vapour.	Calcutta. 1844. Thermometer, dry.	Calcutta. 1844. Thermometer, wet.	Calcutta. 1844. Elastic force.	Calcutta. 1844. Per-centage of vapour.	Aden, 187 feet. 1848. Thermometer, dry.	Aden, 187 feet. 1848. Thermometer, wet.	Aden, 187 feet. 1848. Elastic force.	Aden, 187 feet. 1848. Per-centage of vapour.
January	74°·9	68°·9	·674	79	74°·1	68°·7	·636	76	74°·9	68°·9	·634	74½
February ...	81·4	71·8	·663	63	79·3	72·8	·723	73	75·6	69·4	·643	74
March	86·9	79·9	·920	74	88·4	81·3	·965	74	78·4	72·9	·737	77½
April	91·3	83·2	·918	64	91·5	84·9	1·095	76	81·3	75·4	·800	76¾
May	91·2	84·2	1·066	75	89·0	85·7	1·161	87	86·7	79·4	·902	73
June	89·0	84·3	1·085	79	87·9	85·1	1·144	90	87·4	79·4	·895	71
July	87·0	82·9	1·052	84	85·1	83·7	1·109	93	86·5	77·8	·839	68¼
August	86·6	82·6	1·043	85	84·6	83·3	1·096	94	85·5	76·0	·778	65½
September ...	86·7	82·7	1·046	85	86·4	84·3	1·123	92	86·1	78·0	·851	70¼
October	86·4	80·6	·956	78	84·6	82·8	1·073	93	83·2	75·7	·790	71¼
November ...	80·3	74·4	·772	76	82·1	78·9	·931	87	81·7	71·3	·642	60¼
December ...	74·3	69·1	·762	94	75·9	71·8	·724	82	76·8	69·8	·644	71¼
	83·8	78·7	·905	80	84·07	80·25	·961	84	82·0	74·5	·758	71

Months.	Deccan, mean height 1800 feet. Sunrise 9 to 10 A.M. and 4 to 5 P.M. 1827. Thermometer.	Deccan. Daniell's hygrometer.	Deccan. Elastic force.	Deccan. Per-centage of vapour.	Mahabuleshwur, 4500 feet. Means of 9 years, 1835 to 1843 inclusive. Thermometer, dry.	Mahabuleshwur. Thermometer, wet.	Mahabuleshwur. Elastic force.	Mahabuleshwur. Per-centage of vapour.	Dodabetta, 8640 feet. 1847 to 1848. Monthly means. Thermometer, dry.	Dodabetta. Thermometer, wet.	Dodabetta. Elastic force.	Dodabetta. Per-centage of vapour.	Dodabetta, 8640 feet. Hourly observations, 21st to 22nd. Monthly, 1847–48. Thermometer, dry.	Dodabetta. Thermometer, wet.	Dodabetta. Elastic force.	Dodabetta. Per-centage of vapour.	Month.
January	72°·53	50°·31	·377	47	69°·2	59°·4	·435	61·4	52°·1	46°·15	·277	69	49°·5	40°·3	·190	51½	January.
February ...	75·19	44·39	·308	36	69·6	56·6	·375	52·3	52·3	50·8	·379	93	52·0	50·6	·369	91	February.
March	74·73	48·83	·358	42	75·3	59·6	·396	45·9	53·0	48·8	·323	78	53·3	47·6	·296	71	March.
April	87·22	55·34	·447	36	78·1	62·7	·442	46·9	56·4	53·35	·393	84	52·4	47·2	·296	78	April.
May	84·75	64·54	·608	52	76·4	66·9	·561	62·9	57·2	54·95	·423	88	57·9	56·1	·444	91¼	May.
June	79·99	72·48	·788	84	70·7	68·1	·655	88·1	52·5	51·8	·391	96	52·0	51·5	·389	97	June.
July	77·03	71·69	·768	84	68·8	67·0	·640	91·5	52·60	52·15	·398	97	54·4	53·6	·415	96	July.
August	76·21	71·03	·751	84	67·4	65·7	·611	91·4	53·10	52·5	·401	96	55·1	54·6	·432	97	August.
September ...	77·24	71·11	·753	82	67·9	65·2	·589	86·7	52·45	51·75	·390	96	53·6	53·2	·413	98	September.
October	77·71	58·68	·501	53	68·2	65·8	·489	71·4	53·30	52·8	·406	97	54·2	53·5	·415	96	October.
November ...	75·46	55·54	·451	54	67·3	59·6	·442	66·0	52·15	50·95	·378	94	51·0	43·2	·230	59½	November.
December ...	72·59	51·31	·390	49	66·9	59·1	·434	66·0	50·80	48·75	·341	86	51·8	51·1	·382	96	December.
	77·55	59·60	·516	55	70·4	62·56	·500	66·9	53·16	51·2	·373	90	53·02	50·13	·352	87	Year.

	Madras, sea-level.					Calcutta, 18 feet.									Bombay, sea-level.	Malabar Coast.				Cape Comorin, 50 feet.	Coromandel Coast.				Poona, 1823 feet.					Mahabuleshwur, 4500 feet.			Mercara in Coorg, 4500 feet.	Uttray Mullay, 4500 feet.		Dodabetta, 8640 feet.	
						4 feet.	40 feet.	4 feet.	40 feet.	4 feet.	4 feet.	4 feet.	4 feet.	40 feet.		Cochin, 20 feet.	Quilon, 30 feet.	Allepy, 30 feet.	Trevandrum, 130 feet.		Vaurioor, 60 feet.	Palamcottah, 200 feet.	Shenkottah, 600 or 700 feet.	Kotergherry, 6100 feet.													
	1842.	1843.	1844.	1845.	Means of 22 years, 1822 to 1843.	1843.	1843.	1844.	1844.	1845.	1846.	1847.	1848.	1848.	Means of 32 years, 1817 to 1849. Monsoons.	Means, 1842 to 1846.	Means, 1842 to 1846.	Means, 1842 to 1846.	Means, 1842 to 1846.	1843 to 1846.	Means, 1842, 1843.	Means, 1842 to 1846.	Means, 1842 to 1846.	1847.	1826.	1827.	1828.	1829.	1830.	Means of 15 years.	1834.	1842.	Means, 1838 to 1840.	1845.	1846.	1847, 1848.	
January	1·76	6·40	0·67	1·51	1·33	1·67	1·55	0·22	0·20	1·10	0·82	0·0	0·0	0·0	......	1·72	0·94	1·93	1·80	0·27	0·90	1·33	1·58	1·74	0·0	2·29	0·0	0·0	0·0	0·05	0·0	0·66	0·00	8·40	4·65	0·12	January.
February ...	0·0	0·03	0·49	0·0	0·23	0·64	0·49	0·08	0·05	0·64	1·80	0·0	0·0	0·10	......	0·09	0·33	1·21	0·23	......	0·43	0·92	0·42	13·88	0·0	0·0	0·0	0·0	0·0	0·25	0·25	0·0	0·45	0·15	0·45	7·43	February.
March.........	0·25	0·79	0·0	0·04	0·36	1·20	0·92	0·22	0·15	1·17	2·30	0·0	0·41	0·32	......	2·04	1·98	4·27	1·79	0·92	1·10	1·53	1·99	6·88	0·0	0·4	0·0	0·0	0·0	0·15	0·0	0·02	1·51	14·20	0·73	3·61	March.
April	0·00	0·04	0·00	0·04	0·63	2·42	2·04	3·13	2·63	7·30	0·57	2·33	1·31	1·12	......	3·25	3·14	3·41	3·51	0·75	0·41	1·05	2·61	18·56	0·0	0·0	0·0	0·0	1·04	1·31	{Two showers.}	0·0	2·60	1·37	9·60	19·80	April.
May	0·37	14·07	2·70	1·51	1·03	5·33	4·43	7·44	6·29	2·58	2·49	4·79	6·22	5·51	......	18·97	16·51	26·27	10·27	4·55	3·99	2·39	4·36	No record.	3·41	0·04	1·95	2·74	0·79	3·31	0·16	3·74	7·37	22·68	36·50	4·86	May.
June	1·51	1·93	2·66	2·36	2·03	8·64	7·62	12·13	9·95	10·66	12·14	12·01	13·52	12·68	22·26	30·69	17·90	26·02	13·66	4·56	2·12	0·28	5·29	0·41	3·30	13·47	1·63	4·86	5·57	46·53	32·03	37·86	30·40	52·15	51·05	4·55	June.
July	3·42	1·39	3·22	2·90	3·20	10·18	8·67	13·72	11·40	12·80	20·07	15·69	17·50	16·09	25·04	17·33	11·04	14·63	6·53	0·71	0·97	0·003	3·41	3·70	8·43	1·79	7·58	4·38	5·35	92·10	118·60	117·76	55·88	50·15	33·32	7·45	July.
August	3·07	2·20	2·66	2·01	5·24	20·05	17·99	26·91	22·89	15·36	13·26	15·09	9·22	7·00	17·08	13·09	6·10	9·33	3·31	0·36	0·12	0·006	1·14	2·66	1·03	2·01	3·35	3·21	1·72	72·33	75·91	77·75	27·00	25·57	21·12	9·32	August.
September ...	5·56	4·14	12·42	4·09	4·76	11·19	9·92	5·02	4·25	4·80	9·97	10·95	4·74	4·10	11·25	4·82	3·34	5·32	2·81	0·41	0·53	1·05	1·67	1·36	1·54	4·51	6·92	0·33	0·29	31·32	65·97	56·00	11·91	8·08	7·33	7·52	September.
October	7·99	6·25	13·50	3·36	10·09	2·16	1·88	4·99	4·54	5·86	10·76	5·86	5·41	5·18	*1·19	9·67	9·88	12·02	12·35	8·77	6·51	4·87	7·59	12·33	1·90	4·33	6·34	1·81	3·07	4·58	9·29	7·48	4·60	70·70	38·25	12·49	October.
November ...	12·32	5·27	3·67	5·12	12·42	0·0	0·0	0·0	0·0	0·0	0·74	5·59	0·20	0·13	......	2·28	3·89	5·48	4·61	3·95	4·26	4·19	5·82	10·62	2·33	0·15	2·04	0·0	0·0	2·07	0·0	4·00	1·38	16·10	21·67	11·85	November.
December ...	0·19	7·25	2·32	15·33	3·25	0·86	0·79	0·0	0·0	0·81	1·52	0·05	0·16	0·09	......	2·27	1·68	3·35	4·24	2·80	3·28	3·41	3·30	9·57	0·40	0·0	0·0	1·20	0·0	0·05	{One light shower.}	0·0	0·25	21·00	10·20	12·28	December.
Year	36·39	49·76	44·31	38·27	44·57	64·34	56·30	73·86	62·35	63·08	76·44	72·38	58·69	52·32	76·82	106·06	76·76	113·26	64·54	28·35	24·67	21·06	39·19	81·71	22·34	28·63	29·81	18·53	17·83	254·05	302·21	305·27	143·35	298·55	235·87	101·24	Year.

[Lieut.-Colonel Sykes's Discussion of Meteorological Observations taken in India.]

* This average is for the monsoon months only.

Mean Oscillations of the Barometer corrected for Temperature at Calcutta, Bombay and Madras.

1845.

N. B. These Barometric Curves represent 1st the mean daily oscillations of the barometer for each month of the year. — 2ndly The mean monthly pressure for each month in the year. — 3rdly The Annual curve of pressure. For example. At Bombay in 1845, the mean maximum daily pressure in Jany. was between 9 and 10 a.m. — The mean minimum daily pressure was between 3 and 4 p.m. The mean maximum night pressure was between 10 and 11 p.m. and the mean minimum night pressure was between 3 and 4 a.m. — The mean monthly range of the barometer was from 30.015 to 29.865. — Similarly in the monsoon months of June, July & August the horary oscillations or atmospheric tides continue at the same hours as in January, but the mean range of the Barometer in June is from 29.683 to 29.607.

Mean horary oscillation of the Barometer at CALCUTTA *for the years 1845, 1846, 1847 and 1848.*

J. Basire, lith.

Mean horary oscillation of the Barometer at BOMBAY, for the years 1843, 1844 & 1845.

Mean horary oscillation of the Barometer at MADRAS, for the years 1843, 1844 and 1845.