

XXXI.—*Observations on Atmospheric Electricity.* By C. MICHIE SMITH.
(Pl. CXLVI.)

(Read June 1st, 1885.)

The following observations on atmospheric electricity were made on the top of Dodabetta, between 3rd and 12th January 1885. The position of the electrometer, when not otherwise stated, was at a height of about 5 feet above what remains of the walls of the bungalow formerly used as a meteorological observatory. Dodabetta is the highest hill in the Neilgherries, and the bungalow was built exactly on the top, which is in latitude $11^{\circ} 24' 5'' \cdot 40$ N., longitude $76^{\circ} 46' 44'' \cdot 39$ E., and at a height of 8642 feet above mean sea-level. The top is free from trees, and my tents were slightly below, and at a sufficient distance off to prevent them interfering in any way with the accuracy of the readings.

The rainfall at the end of 1884 was unusually heavy, and continued till near the end of December, so that mists were very frequent in the afternoons and evenings. These mists usually collected over the hollow in which Coonoor and Wellington are situated, and gradually spread round Dodabetta from about E. by N. to W., and at times remained for hours as a sea of mist, with a nearly horizontal, though of course wavy, upper surface, which reached to within a few hundred feet of the top of the mountain. At times portions would be blown off from the surface of this sea, and would reach the hill-top; but usually, during the day, any mist that reached the top dissolved almost instantly on reaching the warmer air rising up the north-west face of the hill from the valley in which Ootacamund lies. Occasionally, however, the top was completely enveloped in mist, and it was impossible to judge with certainty whether it was a condensing or a dissipating one. Unfortunately I had no hygrometer with me; for, knowing the difficulty of making any satisfactory shade, I thought there was no use of taking one. It is, however, worth noticing that the mists after sunset were, as a rule, very wetting, and were therefore probably condensing.

Turning now to the observations, these are interesting in two ways. First, as regards the daily range and period of maximum strength; and, second, as regards the influence of mist. As it was impossible to carry on observations all night without an assistant, I confined myself to an attempt to get a fairly complete series of readings between 7^h and 20^h (Madras mean time, reckoned from midnight). On half the days readings were taken up to 22^h, and on one night to 24^h. From 6th to 12th January the readings were, with two exceptions, taken hourly from 7^h to 20^h, and a number of intermediate readings were taken, when, owing to the presence of mist or from other circumstances, it seemed likely that they would be of value. In all, above 150 observations were made. The morning readings from 7^h to 13^h were little disturbed by mists, except on the 8th, and the readings for these hours agree

remarkably well with each other, so that the diurnal curve for the forenoon may be considered to represent the true curve very fairly; but this cannot be said for the part for the afternoon hours, for on four days out of the nine the readings have almost no value for determining the normal variation. I have thought it well, however, to give a curve (No. 2, Pl. CXLVI.) showing the mean of all the observations, indicating the number of disturbed readings in each case by a corresponding number of marks on the small circle surrounding the point marking the mean. The curve is drawn from the following means of the readings:—

Hours,	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Readings,	44	49	64	71	84	91	95	99	102	98	114	98	82	95	75	59

The other curve (No. 1) shows the means of the two hourly observations on the 4th, 5th, 6th, 7th, and 9th, which are nearly free from the effects of mists. The following table gives the actual observations on these days:—

Hours,	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
January 4, . . . . .	...	52	...	52	...	75	...	68	...	62	...	64	...	59	...	...	...	...
„ 5, . . . . .	...	51	...	72	...	125	...	173	170	132	115	91	...	...	73	67	...	...
„ 6, . . . . .	...	60	65	60	74	78	84	78	68	74	70	75	49	63	...	...	...	...
„ 7,	40	62	66	74	[91]	76	75	92	83	79	64	54	52	[85]	[95]	58	...	...
„ 8,	44	42	72	106	97	115	[142]	[110]	[87]	[84]	[124]	[106]	74	...	90	59	69	62
„ 9,	47	49	65	77	96	111	109	129	125	120	98	60	62	67	56	...	...	...
Mean, omitting the 8th, }	...	55	...	67	...	93	...	108	...	93	...	69	...	...	...	...	...	...

N.B.—Those readings within brackets were taken in mist.

If we take this curve as most nearly the true one, we see that there is a well-marked maximum about 14^h M.M.T., and that the curve is fairly symmetrical on the two sides of this maximum for at least four hours; and there is some evidence, though it is by no means conclusive, that the maximum normal readings are obtained at the time of maximum temperature. The observations made do not fix the time of minimum satisfactorily; but probably there are two minima—one early in the morning and another about 19^h, with a small secondary maximum two or three hours afterwards. This diurnal curve differs entirely from that for Madras, which shows a minimum between 9^h and 10^h, and a maximum about 18^h. The average readings at Dodabetta are also much higher than those at Madras; and, as is to be expected, fine-weather readings in Madras are much more variable than those on Dodabetta.

The readings made during the prevalence of mists were begun simply with the object of testing the assertions frequently made, that while all clouds are positively electrified, they are surrounded by a zone negatively electrified. So

far as my observations went, I never obtained indications of negative electricity either in the clouds or round them; but on some occasions I found the positive charge very small, and I was irresistibly led to the conclusion that, on the edge of a *dissolving* mist, the potential was lower than the normal, while in a condensing mist it was higher than the normal. The following table shows the chief readings that were made in mists:—

No.	Date.	Hour.	Reading.	Remarks.
1	Jan. 3	17 ^h 30 ^m	90	Thin driving mist.
2	" 7	11 ^h	91	Thin mist all round.
3	" "	20 ^h	85	Thin driving mist.
4	" "	21 ^h	95	Do. do.
5	" 8	11 ^h 20 ^m	47	On edge of dissolving mist.
6	" "	12 ^h	115	Mist all gone.
7	" "	13 ^h	142	Heavy mist near.
8	" "	13 ^h 10 ^m	{ 50 to 97 46 }	Mist passing in small quantities, and dissolving over brow of hill.
9	" "	13 ^h 30 ^m	{ to 27 }	In hollow below tents, more mist.
10	" "	13 ^h 40 ^m	75	At post pretty thick mist.
11	" "	13 ^h 50 ^m	22	In hollow mist not so soon dissipated.
12	" "	14 ^h	110	Post—pretty thick mist.
13	" "	14 ^h 20 ^m	29	Thick mist all round.
14	" "	15 ^h	87	Mist all round at a little distance.
15	" "	16 ^h	84	Clear all round below, cloudy above.
16	" "	17 ^h	124	Mist all round, and a little driving over the top.
17	" "	18 ^h	106	Clear. Thin mist below.
18	" "	19 ^h	74	Clear.
19	" 9	16 ^h	120	Mist in distance.
20	" "	16 ^h 40 ^m	49	In hollow—mist drifting past and dissolving.
21	" "	16 ^h 45 ^m	70	Do. Mist all past.
22	" 10	15 ^h	73	Overcast.
23	" "	15 ^h 45 ^m	136	At post thin mist driving past from N.E.
24	" "	15 ^h 55 ^m	{ 66 to 59 }	On ridge to N.E. thin mist; just on edge of cloud.
25	" "	16 ^h	73	Very constant—little mist.
26	" "	17 ^h	{ 160 to 128 }	Mist all round.
27	" "	17 ^h 30 ^m	{ 133 to 145 }	In pretty thick mist.
28	" "	18 ^h	153	In thick mist.
29	" "	19 ^h	100	Clear. Clouds on horizon, and a little sheet lightning on clouds below.
30	" "	28 ^h	82	Thick mist all round, and drifting over the top.
31	" "	16 ^h	150	Still thick mist.
32	" "	16 ^h 20 ^m	137	Thick mist.
33	" 11	{ 17 ^h to 17 ^h 5 ^m }	{ 177 125 166 }	Break in mist.
34	" "			Mist on again.
35	" "			
36	" "	18 ^h	{ 155 to 162 }	Thick mist.
37	" "	19 ^h	109	Mist.
38	" "	20 ^h	149	Dense mist.

Before discussing these it is necessary to note that when the observations were not made at the "post" they were made at places where I found that in fine weather I got readings very nearly the same as those got at the post. It is not necessary to go over the whole table. A few of the more marked cases will sufficiently illustrate the main features.

No. 6 at 11^h 20^m the reading on the edge of a dissolving mist was 47, while the average for that hour is about 87.

No. 8 shows small quantities of mist passing and dissolving, and the readings varying from 50 to 97. The normal reading for this time being about 90.

No. 9. This reading was taken at some distance from the post as the mist was drifting up a ravine to the west, and I stood so as to be just in the mist. The readings were very low—46 to 27.

No. 11, taken at the same place as No. 9, gave a reading of 22. The mist was then thicker, and so went farther before it was completely dissipated, but it was clearly a dissolving mist.

No. 13 is a doubtful case, as the mist was all round, but as it cleared off soon after it was probably even then dissolving.

Nos. 20 and 24 are very clear cases.

No. 26. Here the readings are from 160 to 128 when the normal was about 93. This mist was a very wetting one.

Nos. 27 and 28 are also far above the average.

Nos. 31 to 38 were all in thick condensing mists, and in each case the readings are far above the average. I may add that I purposely avoided examining the observations in detail at the time, and simply recorded as many as possible. It should be noted, too, that in heavy wet mists the readings may at times be too low, as the ebonite which insulates the wire in communication with the inside of the electrometer is apt to get moist in spite of the umbrella. This difficulty is got over by using a match which burns quickly, and by seeing that the ebonite is quite dry before each observation. With a slow burning match I found the results quite untrustworthy.

The observations detailed above are by no means conclusive evidence of the theory that I have ventured to draw from them, but they are sufficient to show the importance of a much more careful examination of the electrical state of condensing and dissipating mists. Such observations would be of great value in connection with the discussion of the cause of thunderstorms, and if my results are confirmed by more extended observations strong support will be given to the theory which looks on the condensation of a number of slightly charged particles into large drops as the cause of the high potential indicated by disruptive discharges. It has been suggested as an explanation of some of my observations that every cloud is surrounded by a zone at a lower potential