LETTERS TO THE EDITOR

THE APPARENT SHAPE OF THE MOONLIT OVERCAST SKY

IN an earlier note in this *Journal*,[1] the author has reported the measurements of the half-arc angle[2] under various conditions of clouding in the sky during day-time. They led to the anomalous conclusion that the half-arc angle decreases with increasing cloud-height, contrary to what should be expected on a geometrical basis. It was felt worthwhile to investigate whether the behaviour of the half-arc angle would be similar in the case of overcast night skies also. The results of such a study are reported in this article.

In the absence of the moon in the night sky, the clouding in the sky would be indiscernible, and the overcast would appear equally dark to the eye, irrespective of the height of its base. It is, therefore, only on moon-lit nights that such measurements could be carried out. As the intensity of illumination present in the sky may itself influence the half-arc angle to an uncertain degree,[3] measurements were made only on days when the moon was full or nearly so and was sufficiently clear of the horizon so as to illuminate the clouding uniformly. On most of the occasions reported here, the skies were totally overcast and, on the rest, they were nearly so. The times of observation were between 21.00 and 24.00 hrs. I.S.T. The heights of base of cloud were visually estimated. The half-arc angle was measured as before.[2,3] Eight measurements were taken on each occasion in four different directions, and their arithmetical mean was adopted as the representative value.

The results are reproduced in Table I below. In the last column of this table are given the corresponding values of the half-arc angles for the day-time skies, picked up graphically from the measurements of the author[1] and of Miller and Neuberger.[4]

TABLE I

Date	Height of base of cloud in feet	Half-arc angle for full-moon night sky in degrees	Corresponding half-arc angle during day time in degrees
13-6-1946	2,500	22·6	28·6
14-6-1946	3,000	22·8	28·4
9-9-1946	5,000	23·2	27·7
14-7-1946	7,000	23·7	27·4
13-7-1946	10,000	24·7	27·1
9-9-1946	13,000	25·5	26·6
9-9-1946	16,000	26·0	26·3
10-9-1946	22,000	26·5	25·4

The most interesting feature of the above results is that the half-arc angle for the overcast night skies shows an actual increase with increasing cloud-height, quite unlike during day-time. This is in accordance with what may be deduced on a purely geometrical basis. For, if O is the position of the observer, H that of the apparent horizon and Z the zenith, the greater the value of OZ, the higher would be the half-arc angle for the same value of *OH*. The true explanation is, however, not so simple; for, the situation is complicated by the fact that perception of depth is to a great extent subjective.[3] The thicker and darker a cloud, the more convex does the sky look to the eye. The influence of this subjective impression so far outweighs the geometrical fall of the half-arc angle due to decrease in the height of the cloud-base during day-time that the net effect is one of its actual increase. Such an explanation for this anomaly is justified because, during day-time, the value of *OH* is unaffected by the elevation of the cloud-base and is mainly determined by the existing conditions of visibility. During night-time, on the other hand, when the skies are overcast, due to the prevalence of darkness all round, the apparent value of *OH* would vary subjectively with the illumination that obtains on the furthest fringes of the cloud canopy. The value of *OZ* would similarly depend upon the zenithal luminosity of the overcast. With increasing cloud-height on moon-lit nights, *OH* ond *OZ* would, therefore, vary both objectively and subjectively.

The thicker the cloud during the moon-lit night, the darker it looks both at the zenith as well as near the horizon. This would make the distances of *OH* as well as *OZ* appear equally enhanced. The influence of subjective impression on *OH* may thus almost neutralise that on *OZ*. The variation of the half-arc angle with elevation of cloud-base may, therefore, become effectively objective.

A matter of practical interest that emerges from this study is the usefulness of the results reported here for the determination of the height of base of cloud during moon-lit nights. When the sky is overcast during the night, it is difficult for an observer on the ground, particularly in poor moon-light, to distinguish between different types of clouds and much more so to estimate their heights of base. Experience shows that searchlight observations are not quite possible in the presence of moonlight, as the beam of light fails to sufficiently illuminate the base of the cloud to enable observation from the ground, except when the cloud base is very low and the moon is very feeble. A mere measurement of the half-arc angle would, on such occasions, enable a fairly accurate judgment of the cloud-base. If a graph be drawn between the half-arc angle and the height of cloud-base using the data reported here, the height corresponding to any angle can be easily read off therefrom. Such a graph shows that the relationship between the half-arc angle and the height of the cloud-base is almost linear up to about 15,000 feet.

The usefulness of the above graph is not limited to the overcast full-moon skies only. For, some of the measurements made by the author, during the course of his work on the effect of illumination on the apparent shape of the sky, show that the half-arc angle for any overcast sky, when the moon is half is practically the same as when the moon is full. The graph can, therefore, be used for all states of the moon from half to full. Nevertheless, when the sky is thickly overcast with a deep layer of low cloud, the moon-light may so completely be cut off as to render the clouding imperceptible. On such occasions it may not be possible to determine the half-arc angle. But under such conditions, cloud-height can be easily measured by the searchlight method.

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1. Venkateswara Rao, D., *Curr. Sci.*, **1947**, **16**, 55. 2. —, *Ibid*, 1946, **15**, 40. 3. —, *Proc. Ind. Acad. Sci.*, **1947**, **25**, 34. 4. Miller, A., and Neuberger, H., *Bull. Amer. Met. Soc.*, 1945, **26**, 212.

A PROPOSED NEW COMPONENT OF SOLAR RADIATION

In a previous communication[1] the author examined variations in the selective absorption of light by molecules of the earth's lower atmosphere in the region of the oxygen absorption bands, and suggested that these were due, in part, to action on the molecules of a high-powered component within the earth's fair-weather electric field.[2] A comparative study of fundamental atmospheric electric phenomena has, however, indicated an additional, possible contributory factor.

In the accompanying comparison diagram are reproduced, with Greenwich mean time as abscissa and a variable ordinate (for which reference should be made to the original papers) the following curves:

(*a*) Curve 'e' in Fig. 2 of Price and Chapman's[3] estimate of diurnal variations in the non-vanishing, terrestrial magnetic, line-integral current flowing across a representative region of the earth's surface;

(*b*) Curve 7 in Fig. 3 of Hogg's[4] variations in the rate of production of small ions in the lower atmosphere in fair weather;

(*c*) the mean of the electrogram and curve shown in Figs. 3 and 4 respectively of the diurnal variations in the apparent vertical component of the earth current observed by Forbush[5];

(*d*) curve of variations in the potential gradient of the earth's electric field from a typical. fair-weather electrogram of Colaba Observatory, set to G.M.T.;

(*e*) curve of Medi's[6] observations of day-time variations in atmospheric radiation, placed adjacent to Curve 1 in Fig. 1 of the author's own[7] qualitative observations of night-time variations in atmospheric radiation intensity, particularly in the region of the oxygen absorption bands (the red), the resultant indicating a marked correlation with the atmospheric potential gradient; and

(*f*) a curve constructed from Perot's[8] remarks on daily variations in the frequency of lines in the "B" band of the atmospheric oxygen absorption spectrum.

It will be seen that in every case there is, broadly speaking, a primary minimum in intensity at about noon, and a primary maximum at about 17.00 hours, both by G.M.T. The only