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THE USE OF THE CAMPBELL STOKES SUNSHINE RECORDER AS AN INTEGRATING ACTINOMETER

Galindo Estrada and Fournier D'Albe (1960) have described a method to evaluate the daily total direct solar radiation by measuring the weight of paper burnt in the Campbell Stokes sunshine recorder. They have claimed that the loss of weight of paper is a direct measure of the amount of radiation received and that the sunshine recorder can, therefore, be used as an integrating actinometer, capable of measuring the intensity of solar radiation to an accuracy of the order of ± 11 per cent.

Estrada and D'Albe had made the comparison making use of the direct solar radiation at normal incidence obtained with an Eppley actinometer on a heliostatic mounting. However, the measure of incoming solar radiation which is most generally useful is that of the total energy falling on a unit area of horizontal surface, integrated over suitable periods. It was, therefore, decided to try the experiment in respect of the radiation received on a horizontal surface, total T as well as total—diffuse (T—D). Computation was also made of (T—D) cosec h (where h is the solar elevation), in order to obtain the direct value at normal incidence from the (T—D) values received on a horizontal surface so that a strict comparison may be possible with the methods used by the above authors.

The experiment was conducted at the Central Agricultural Meteorological Observatory at Poona (Lat. 18°32′N, Long. 73° 51′E, 559 metres a.s.l.). The sunshine recorder used was a Campbell-Stokes sunshine recorder installed on the terrace of the radiation laboratory. On the same terrace were also installed two Moll-Gorczynski solarimeters, one for measuring the total radiation from the sun and sky on a horizontal surface and the other provided with a shading ring attachment for the measurement of diffuse radiation only. Both were connected to a Thread recorder (Cambridge Instr. Co. Ltd.).

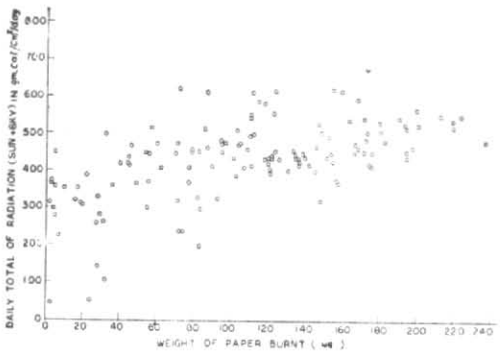

Fig. 1

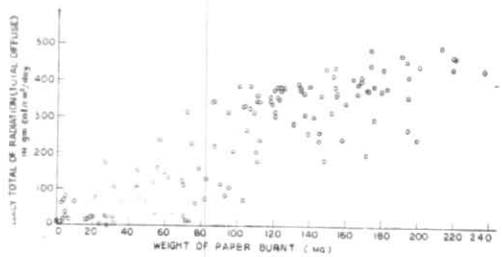

Fig. 2

The sunshine cards used were the standard cards used by the India Meteorological Department. The card to be used on each day was thoroughly dried in the laboratory oven for at least one hour and then allowed to cool in desiccator. It was then weighed quickly in a sensitive balance. The card was exposed on the sunshine recorder and after removal weighed again after thoroughly drying in the oven.

The difference in weight of the cards before exposure and after exposure was plotted against (1) total radiation T, (2) total—diffuse radiation $(T—D)$ and (3) $(T—D)$ cosec h, pertaining to the same day, as obtained from the Moll-Gorczynski solarimeter. Figs. 1—3 give the plotted values making use of readings during the period June to December 1961 which included days of clear skies, partly clouded skies and overcast skies.

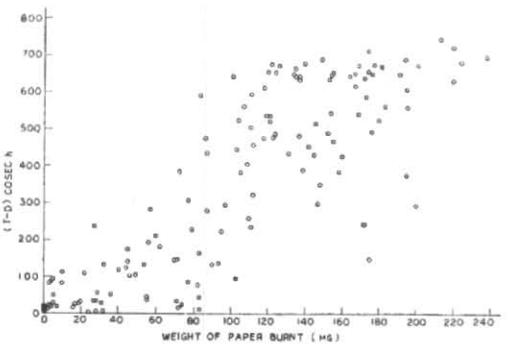

Fig. 3

It may be seen readily from Fig. 1 that the scatter of the points is much too large to give any direct relationship between weight of paper burnt and the total radiation (direct + diffuse) on a horizontal surface. The values plotted in Fig. 2 show that even after excluding diffuse radiation which does not burn the sunshine card, the rest of total radiation which consists of direct radiation only does not show useful correlation with weight of card burnt. Fig. 3 shows practically the same features as Fig. 2 and does not show better correlation even at normal incidence. In view of the wide scatter obtained of the points, it was considered that no useful purpose will be served by working out correlation coefficients.

The above result is not surprising in view of the following—

(*i*) A certain amount of solar radiation is necessary to burn the portion of the sunshine card exposed to the rays concentrated by the sphere of the sunshine recorder. This will result in a certain loss of weight of the card. Any further increase in the intensity of radiation does not increase the portion of the card burnt, but just passes through the portion already burnt. Consequently there is no further increase in the loss of weight of the card with increase in radiation.

(*ii*) It is well known that we can have days with the same number of hours of bright sunshine in two months, *e.g.*, November and May in Poona. But the intensity of total solar radiation on such a day in November is appreciably less than the intensity on the day with the same number of hours of bright sunshine in May. The loss of weight of the sunshine records on the two days will, however, be more or less the same.

(*iii*) The sunshine card may not get burnt at all during hours when the sun's disc is covered by clouds but a considerable amount of diffuse radiation will nevertheless be received during these hours. Hence the methods of weight cannot give reliable indication of global radiation.

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REFERENCE

Galindo Estrada and Fournier D'Albe 1960 *Quart. J. R. met. Soc.*, **86**, p. 270.