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SOLAR RADIATION AND AIR TEMPERATURE MEASUREMENTS DURING THE SOLAR ECLIPSE OF 16 FEBRUARY 1980*

During solar eclipse, the sun's disc is covered for a brief period and this can reduce the radiation received at the earth considerably. The earlier total solar eclipse occurred in India was in 1898. Survey of India (1898) and the Maharaja Takhtasinghji Observatory, Poona (1898) have recorded their temperature observations of the eclipse in their reports. Sir John Eliot (1898) has compiled the meteorological observations taken at 154 stations during that eclipse and analysed. Jagannathan *et al.* (1957) studied the solar radiation pattern of a partial solar eclipse in 1955 recorded at Poona. In the present study, the direct solar radiation measurements and the surface temperature observations taken at certain selected sites in India during the recent solar eclipse were analysed and the results are presented.

2. The fall in insolation was seen at Trivandrum, Madras, Nagpur, Bombay, Goa and Hyderabad.

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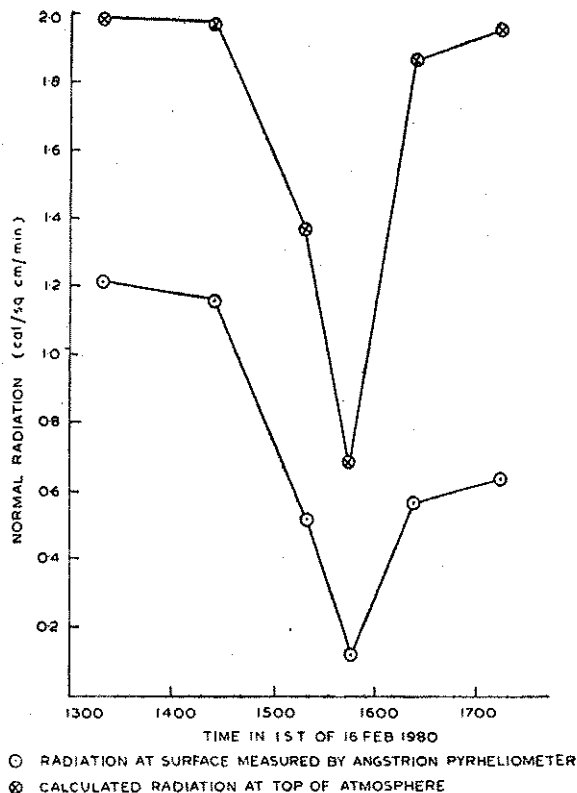


Fig. 1. Insolation at Madras on 16 February 1980

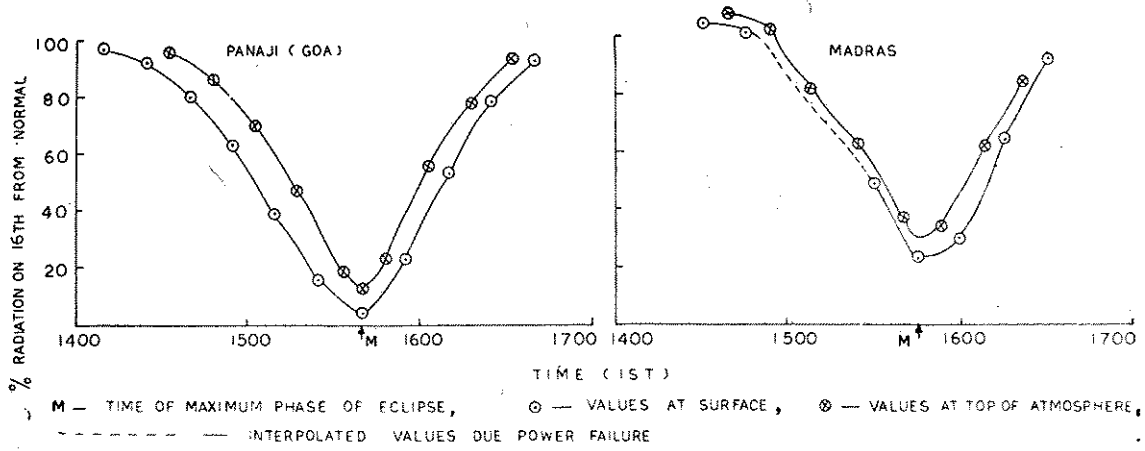


Fig. 2

Fig. 3

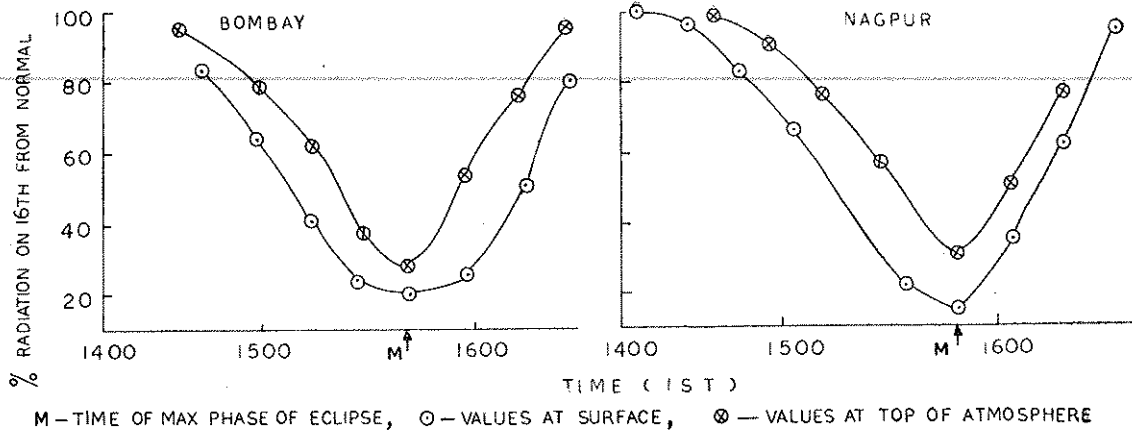


Fig. 4

Fig. 5

Among these stations, the eclipse was near total (magnitude=0.99) at Goa and Hyderabad while the magnitude varies from 0.82 to 0.87 in the rest places. Surface temperature measurements were made in all these stations and also in a few more stations that were inside the totality path.

The radiation measurements at all the stations were made by the Moll-Gorczymski pyranometer and recorder. Total radiation and diffuse sky radiations were measured and from this the direct solar radiation on a horizontal surface averaged over 15 mts period was arrived at. The radiation measurements were repeated on 15, 16 and 17 February. The average of the quantities observed on 15th and 17th was

taken as normal values, and the percentage reduction of radiation observed on 16th from this was worked out. The percentage deviation is taken as the parameter for consideration.

Similarly for temperatures also, the quantities were observed on 15, 16 and 17th and the deviation of the temperature at any instant from the average of temperatures observed at the same instant of 15th and 17th was taken as the parameter for discussion. This is attempted so in order to reduce any influence due to local condition to the least and to make the comparison between quantities measured at different sites meaningful.

If we assume that the energy received from the sun

TABLE 1

Station	Magnitude of eclipse	Maximum fall in Temp (°C)	Time (IST)
Gadag	1.04	2.1	1546
Raichur	1.04	2.4	1548
Bellary	1.04	2.4	1544

TABLE 2

Station	Magnitude of eclipse	Maximum fall observed in °C
Bombay	0.87	1.6
Madras	0.89	1.5
Trivandrum	0.80	1.6
Hyderabad	0.99	1.6

is radiated with uniform intensity from the entire sun's disc one can calculate the amount of depletion of solar energy at the boundary of earth's atmosphere due to a specified magnitude of the eclipse. This was also calculated for 15, 16 and 17th and the value on 16th is spoken as the percentage of the mean of 15th and 17th for consideration.

At Madras hourly observations with Angstrom pyrheliometer of direct solar radiation incident on a normal surface were available. Flux of solar radiation F_t reaching unit area at the boundary of earth's atmosphere at time t can be indicated by

$$F_t = S(1-w_t)/(1-e^{2\pi d/T})^2$$

where, S —Solar constant,

w_t —proportion of sun obscured by noon at time t ,

e —ellipticity of earth's orbit,

d —No. of days from 1 January : T periodic time in days (=365.26 days)

The radiation at surface was measured during the passage of the eclipse and the corresponding quantity at the top of atmosphere was calculated using the above formula.

Fig. 1 shows the plot of normal incident solar radiation at surface and at top of atmosphere over Madras. There is a steep fall in value at 1546 IST which corresponds to the maximum phase of the eclipse. The rise after the maximum phase of eclipse is also seen. There is a difference of about 0.558 cal/cm²/sec (0.6770 — 0.1189 = 0.5581) in the radiation amounts received at top of atmosphere and at surface at the time of maximum phase of the eclipse.

Fig. 2 shows the plot of percentage deviation of the direct solar radiation on horizontal surface on 16th observed during the phases of the eclipse at

surface and that calculated at the top of the atmosphere pertaining to Goa. The maximum fall of radiation corresponding to the time of maximum phase of eclipse is uniform from the beginning. However the rise at the receding phase of the eclipse is a bit rapid comparatively. A similar tendency was observed for Hyderabad also (not shown here).

Figs. 3, 4 and 5 are the graphs pertaining to Madras, Bombay and Nagpur. Here also we find the fall is steady while the rise after the maximum phase is comparatively rapid. However, the symmetry is less when compared to Goa pattern. The percentage reduction near the time of maximum phase of eclipse varies from station to station in accordance with the magnitude of the eclipse. Jagannathan *et al.* (1957) have also observed the maximum fall in radiation just around the time of maximum phase of a partial eclipse during 1955 and similar finding for a partial eclipse in 1963 was made by Pruit *et al.* (1965).

The observation of surface temperature is also very interesting. Table 1 gives the fall in temperature from the average of values observed on 15 and 17 February on the eclipse day at places in the totality path. The maximum fall observed was 2.4 deg. C. However as per the available records a fall of 4 deg. C was observed during the total eclipse of 22 January 1898 at Poona and at Sahdol (Survey of India 1898, Maharaja Takhtasinghji observatory 1898).

The temperature observation of some other stations where eclipse was not total are given in Table 2. The fall at all the places is less than 2 deg. C. No appreciable change in humidity or pressure could be observed during the eclipse.

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