

## Radiation measurements during the solar eclipse on 23 November 1965

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सार—23 नवम्बर 1965 को हुए वलयाकार सूर्य-ग्रहण के संदर्भ में तीन दिन तक सौर विकिरण प्राचलों की विशेष मापें ली गईं। पूर्ण में ग्रहण का परिमाण 0.56 था। सौर विकिरण के बैंगनी-नीले क्षेत्र में तीव्रता का ह्रास उल्लेखनीय था और यह दीर्घ तरंगदैर्घ्य की तीव्रता से अधिक थी। सीधे सौर विकिरण, भूमण्डलीय और विसरित सौर विकिरणों एवं कुल विकिरणों के परिणामों को प्रस्तुत किया गया है। दूसरे स्थानों पर लिए गये विकिरण प्राचलों का, इन मापे गए प्राचलों से तुलना की गई है।

**ABSTRACT.** Special measurements of solar radiation parameters were made for three days in connection with the annular solar eclipse which occurred on 23 November 1965. The Magnitude of the eclipse was 0.56 at Poona. A reduction in intensity for the violet-blue region of the solar radiation was noticeable and it was higher than that for the longer wavelengths. The results of direct solar radiation, global and diffuse solar radiation and net radiation are presented. A comparative study of the radiation parameters measured with those obtained at other stations is also made.

### 1. Introduction

An annular eclipse of the sun occurred at Poona ( $18^{\circ} 32' N$ ,  $73^{\circ} 51' E$ ) on 23 November 1965. The eclipse commenced at 0701 IST (0640 Lat.). The sun's disc was eclipsed to the maximum extent of 56 per cent at 0804 IST (0743 Lat.) and the last contact was at 0914 IST (0853 Lat.). The total duration of the eclipse at Poona was 2 hours and 13 minutes. In Calcutta and Delhi the area of the sun's disc eclipsed was greater, being 89 per cent respectively.

Integral and spectral measurements of direct solar radiation and continuous records of global and diffuse solar radiation and net radiation were made at Poona on the 22, 23 and 24 November 1965 in connection with the solar eclipse. An Ångström pyrheliometer with Schott glass filter  $OG_1$ ,  $RG_2$  and  $RG_8$  was used for measuring direct solar radiation and thermoelectric pyranometer for global and diffuse solar radiation. Records of net radiation were obtained with a funk type net pyrriadiometer.

In addition to the measurements made at Poona, continuous measurements of global and diffuse

solar radiation and net radiation were made at New Delhi, Calcutta, Madras, Jodhpur, Kodaikanal and Trivandrum.

### 2. Results of measurements at Poona

#### 2.1. Direct solar radiation

In Figs. 1-4 are plotted the integral and spectral intensities of direct solar radiation measured at Poona on 22, 23 and 24 November 1965. The measurements could be started only 0800, 0742 and 0920 hours Lat. on 22, 23 and 24 November respectively due to hazy and misty conditions earlier. In Fig. 1 shows the plots of integred values of direct solar radiation for the three days in the entire range ( $0.300-3.000\mu$ ). It may be seen that at the maximum phase there was a reduction of over 60 per cent in the values of direct solar radiation. Figs. 2, 3 and 4 give the spectral intensities in the ranges  $0.300$  to  $0.525\mu$ ,  $0.525$  to  $0.630\mu$  and  $0.630$  to  $0.710\mu$ . There is a very pronounced reduction in the violet-blue radiation at the time of the eclipse, the value being  $.004 \text{ cal cm}^{-2} \text{ min}^{-1}$  at the maximum phase of the eclipse.

Fig. 5 shows the intensities of direct solar radiation received on a horizontal surface, computed

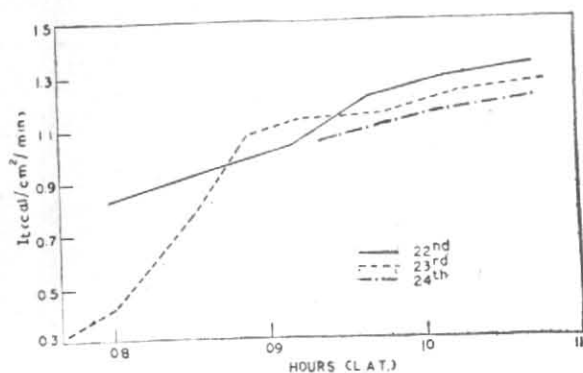


Fig. 1. Variation of direct solar radiation at Poona

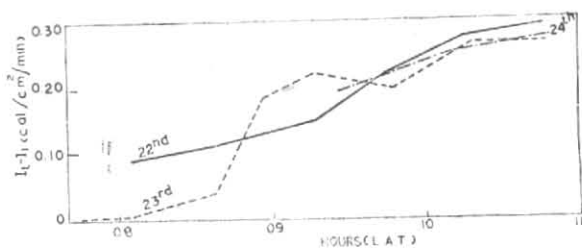
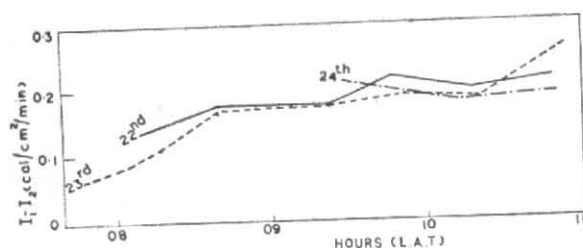
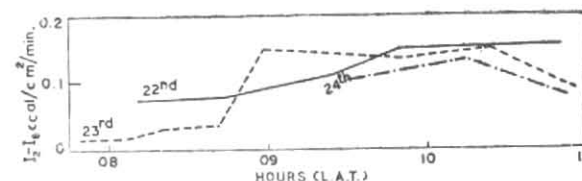
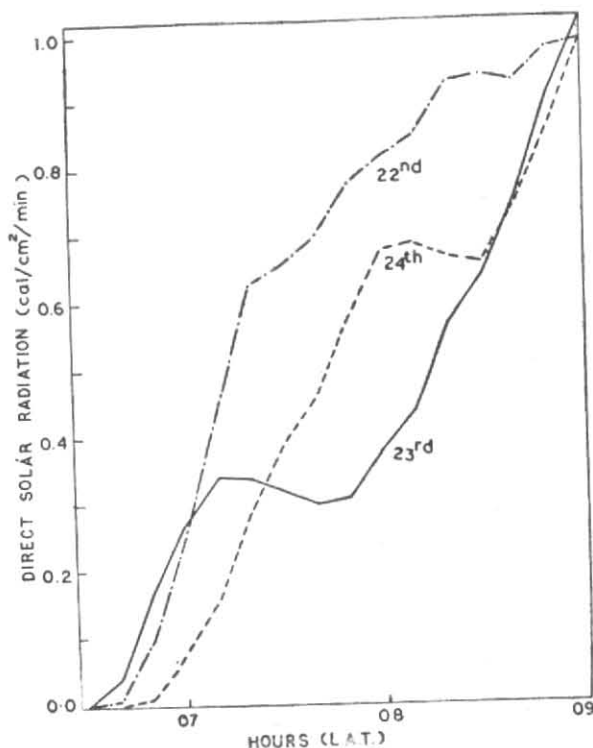
Fig. 2. Variation of direct solar radiation for wave length less than  $0.525\mu$  at PoonaFig. 3. Variation of direct solar radiation for wave-lengths in the range  $0.525$  to  $0.630\mu$  at PoonaFig. 4. Variation of direct solar radiation for wave-lengths in the range  $0.630$  to  $0.710\mu$  at Poona

Fig. 5. Variation of direct solar radiation at Poona

from the continuous records of global and diffuse solar radiation at Poona. Here again the fall in intensity at the maximum phase is of the order of 60 per cent, in agreement with the observations made by Padmanabhamurthy and Rakshit (1966).

## 2.2. Direct fluxes of illumination

Ångström and Drummond (1962 a, 1962 b) derived from theoretical considerations a method of computing the flux of direct illumination from

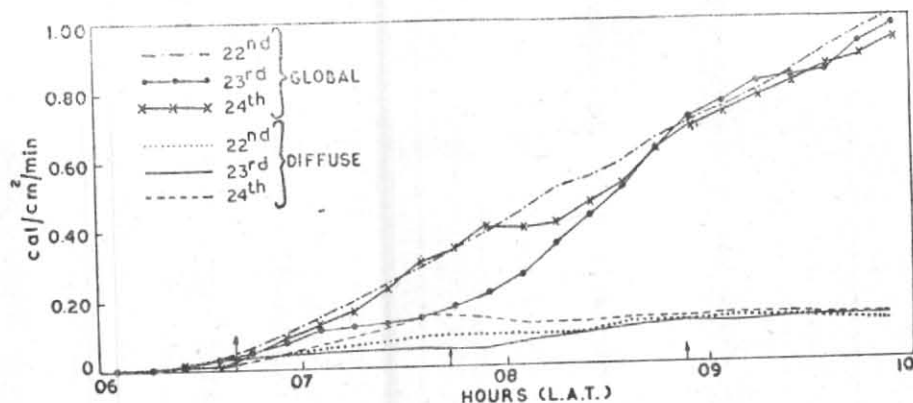


Fig. 6. Variation of global and diffuse solar radiation at Poona

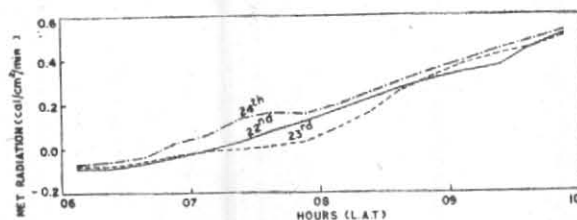


Fig. 7. Variation of net radiation at Poona

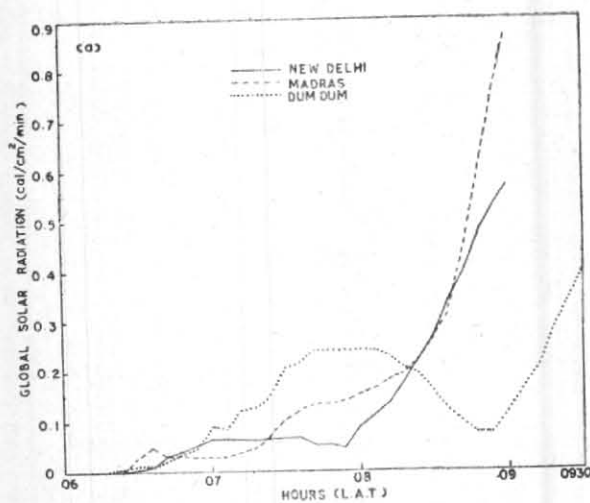


Fig. 8 (a). Variation of global solar radiation at New Delhi, Madras and Calcutta on 23 Nov 1965

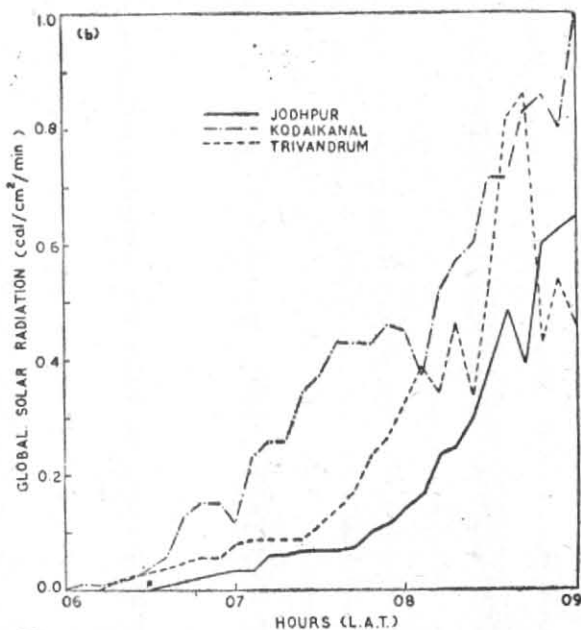


Fig. 8 (b). Variation of global solar radiation at Jodhpur Kodaikanal and Trivandrum on 23 Nov 1965

integral and spectral measurements of direct solar radiation using Schott glass filters  $OG_1$ ,  $RG$  and  $RG_8$ . For measurements without filter and with filter  $RG_8$ , the direct illumination flux is given by :

$$E = 575 \rho W$$

Where,  $E$  is the illumination flux in Kilolux.

$W$  is the radiation in  $\text{cal cm}^{-2} \text{min}^{-1}$  below the lower wavelength outoff of  $RG_8$  filter and  $\rho$  the luminous efficiency given by :

$$\rho = .315 (1 + .032 m)$$

where,  $m$  is the optical airmass. Values of direct fluxes of illumination calculated in the above manner showed that at the maximum phase of

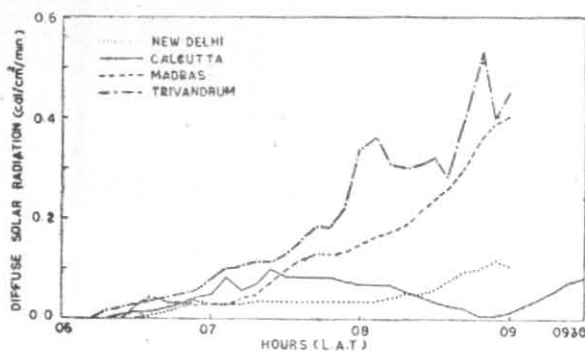


Fig. 9. Variation of diffuse solar radiation at Calcutta, New Delhi, Madras and Trivandrum on 23 November 1965

the eclipse, there was significant reduction in the value (4 Kilolux) compared to the previous day.

### 2.3. Global and diffuse solar radiation and net radiation at Poona

The variation with time of global and diffuse solar radiation at Poona on the three days from 6 to 10 hours Lat. are plotted in Fig. 6. The value of global solar radiation at the maximum phase is only  $0.17 \text{ cal cm}^{-2} \text{ min}^{-1}$  while on the previous day at the same time it was  $0.33 \text{ cal cm}^{-2} \text{ min}^{-1}$ . The corresponding values for diffuse radiation are  $.05$  and  $.09 \text{ cal cm}^{-2} \text{ min}^{-1}$ . Except for haziness, the sky was clear on all the three days during the eclipse.

The value of net radiation recorded at Poona for 22, 23 and 24 November are plotted in Fig. 7. At the maximum phase of the eclipse net radiation was reduced to  $0.02 \text{ cal cm}^{-2} \text{ min}^{-1}$  which is  $.07 \text{ cal cm}^{-2} \text{ min}^{-1}$  less than the value on the previous day corresponding to the same time, amounting to a reduction of 78 per cent.

### 2.4. Global and diffuse solar radiation and net radiation at a few other stations

In Figs. 8(a) and 8(b) are plotted the values of global solar radiation on the day of the eclipse at New Delhi, Madras, Calcutta, Jodhpur, Kodai-kanal and Trivandrum. The time of maximum phase of the eclipse at each station is shown by an arrow against the curve. At Calcutta the minimum value of global solar radiation was  $.06 \text{ cal cm}^{-2} \text{ min}^{-1}$  and at Delhi  $.05 \text{ cal cm}^{-2} \text{ min}^{-1}$ . The

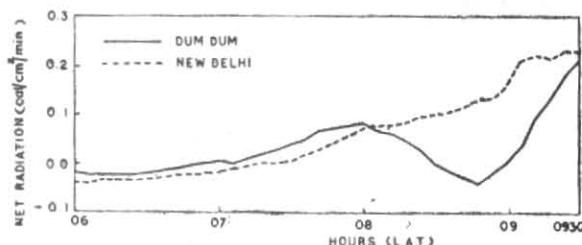


Fig. 10. Variation of net radiation at New Delhi and Calcutta on 23 November 1965

fall in the intensity at other stations was masked by cloudy or hazy conditions. Fig. 9 gives corresponding values of diffuse solar radiation. The effect of the eclipse is clearly seen in the curve for Calcutta where at the maximum phase diffuse solar radiation reaches  $.01 \text{ cal cm}^{-2} \text{ min}^{-1}$ . At New Delhi the corresponding value is  $.03 \text{ cal cm}^{-2} \text{ min}^{-1}$ .

The variations of net radiation at Calcutta and New Delhi are plotted in Fig. 10. The lowest value at Calcutta is  $-0.4 \text{ cal cm}^{-2} \text{ min}^{-1}$ . No marked fall is noticed in the curve for New Delhi. The value at the maximum phase of the eclipse is  $+ .05 \text{ cal cm}^{-2} \text{ min}^{-1}$ .

### 3. Conclusion

The spectral measurements of direct solar radiation at Poona suggests that the reduction intensity is higher for the violet-blue region of the spectrum than for longer wave-lengths. The reduction in the integral value of direct solar radiation corresponds to the extent of the eclipsed portion of the sun's disc.

### References

- Angström, A. K. and Drummond, A. J., 1962 (a), Fundamental principles and methods for the calibration of radiometers for photometric use, *Applied Optics*, 1, pp. 455-464.
- Angström, A. K. and Drummond, A. J., 1962 (b), On the evaluation of natural illumination from radiometric measurements of solar radiation, *Archiv. fur. Met. Geo. Bio. Ser. B*, Band 12, 1 Heft., pp. 41-46.
- Padmanabhamurthy, B. and Rakshit, D. K., 1966, Variations in radiation, ozone and some meteorological and soil parameters during the eclipse on 23 November 1965 at Dum Dum, *Indian J. Met. Geophys.*, 17, 4, pp. 617-622.