

# SOLAR RADIATION DURING THE ECLIPSE OF 20 JUNE 1974

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## INTRODUCTION

A total solar eclipse occurred on 20 June 1974 with a path of totality over the Indian Ocean and touching the southwest tip of Western Australia. The reduction in solar radiation attending the eclipse was registered by pyranometers in the Bureau of Meteorology global radiation network. The purpose of this brief note is to describe the pyranometer observations and to account for the extent of the reduction in solar radiation.

## DATA AND TREATMENT

Pyranometer records from seventeen Australian sites are considered. For each site the time of the middle of the eclipse is computed following the Astronomical Ephemeris (US Naval Observatory, 1971), and also the fraction of the area of the solar disc exposed at this time. To minimise chart time errors the times of sunrise and sunset are computed for each site and the chart time adjusted so that the irradiance trace begins and ends symmetrically about these times. The irradiance is read off the chart at the time of the middle of the eclipse and expressed as a fraction of the irradiance recorded at the same time on a clear day within a few days of the eclipse day. The results are set out in Table 1 together with cloud observations at the time of the eclipse, and shown graphically in Fig 2. For sites at which the sky is fairly clear of cloud during the eclipse the time integrated radiation loss is measured by planimetry the area between the irradiance trace on the eclipse day and a nearby clear day. These results are shown in Table 2. One of the clearer pyranometer charts, that for Port Hedland, is shown in Fig 3.

## DISCUSSION

The duration of the eclipse ranged from about one and a half hours at the western edge of the continent to one hour at the eastern edge. The path of the umbra or total eclipse and the northern limit of the penumbra or partial eclipse are shown in Fig 1. The eclipse moved eastwards over the continent, so that the time of the middle in the west was about one hour Greenwich Mean Time earlier than in the east. In local time the time of the middle ranged from about 1310 Western Standard Time at the western edge of the continent to 1610 Eastern Standard Time at the eastern edge.

Most global irradiance values at the time of the middle of the eclipse are reduced from the expected clear sky global irradiances in proportion to the fraction of the solar disc observed as shown by Fig 2. Where global irradiances exceed the expected values, notably at Darwin, Halls Creek and Longreach, they do so by only a few per cent and this can be supposed due to augmentation by diffuse radiation from clouds which are not depleting the direct beam irradiance. Zillman (1972) reports such augmentation of up to  $100 \text{ W m}^{-2}$ , which is adequate to explain the present results. Where global irradiances are less than the expected clear sky values, notably at Laverton, Melbourne, Mildura, Mt Gambier, Wagga and Williamtown, this can be explained by dense cloud cover. At the first five of these sites there is more than five-eighths of low cloud, and at Williamtown four-eighths of altocumulus.

Table 1 Fraction of the solar disc area exposed at the time of the middle of the eclipse, and observed global irradiance expressed as a fraction of the expected clear sky value.

Station	Latitude S	Longitude E	Time of middle of eclipse (GMT)	Solar disc exposed	Global irradiance	Cloud present
Geraldton (G)	28° 48'	114° 42'	0514	0.06	0.03	8/8 double layered altocumulus
Pearce (PE)	31° 40'	116° 00'	0517	0.02	0.04	2/8 altocumulus 5/8 cirrus
Albany (A)	34° 57'	117° 48'	0521	0.00	0.00	1/8 altocumulus 6/8 cirrostratus
Port Hedland (PO)	20° 23'	118° 37'	0523	0.36	0.35	2/8 cirrus
Forrest (F)	30° 50'	128° 06'	0541	0.19	0.20	1/8 cumulus 7/8 cirrostratus
Halls Creek (H)	18° 14'	127° 40'	0541	0.56	0.61	6/8 cirrus
Darwin (D)	12° 26'	130° 52'	0547	0.78	0.82	7/8 cirrostratus
Oodnadatta (O)	27° 33'	135° 28'	0553	0.41	0.42	3/8 cirrus
Woomera (WO)	31° 09'	136° 48'	0554	0.32	0.30	3/8 stratocumulus
Mt Gambier (MT)	37° 45'	140° 47'	0555	0.19	0.10	4/8 cumulus 2/8 stratocumulus
Mildura (MI)	34° 14'	142° 05'	0558	0.31	0.07	5/8 cumulus 3/8 stratocumulus
Laverton (LA)	37° 52'	144° 45'	0559	0.25	0.13	3/8 cumulus 3/8 stratocumulus
Melbourne (ME)	37° 49'	144° 58'	0559	0.25	0.00	3/8 cumulus 3/8 stratocumulus
Wagga (WA)	35° 10'	147° 28'	0603	0.37	0.17	5/8 stratocumulus
Longreach (LO)	23° 26'	144° 15'	0604	0.68	0.73	1/8 cumulus
Williamtown (WI)	32° 49'	151° 50'	0607	0.52	0.33	4/8 altocumulus
Rockhampton (R)	23° 23'	150° 29'	0610	0.77	0.76	2/8 cumulus

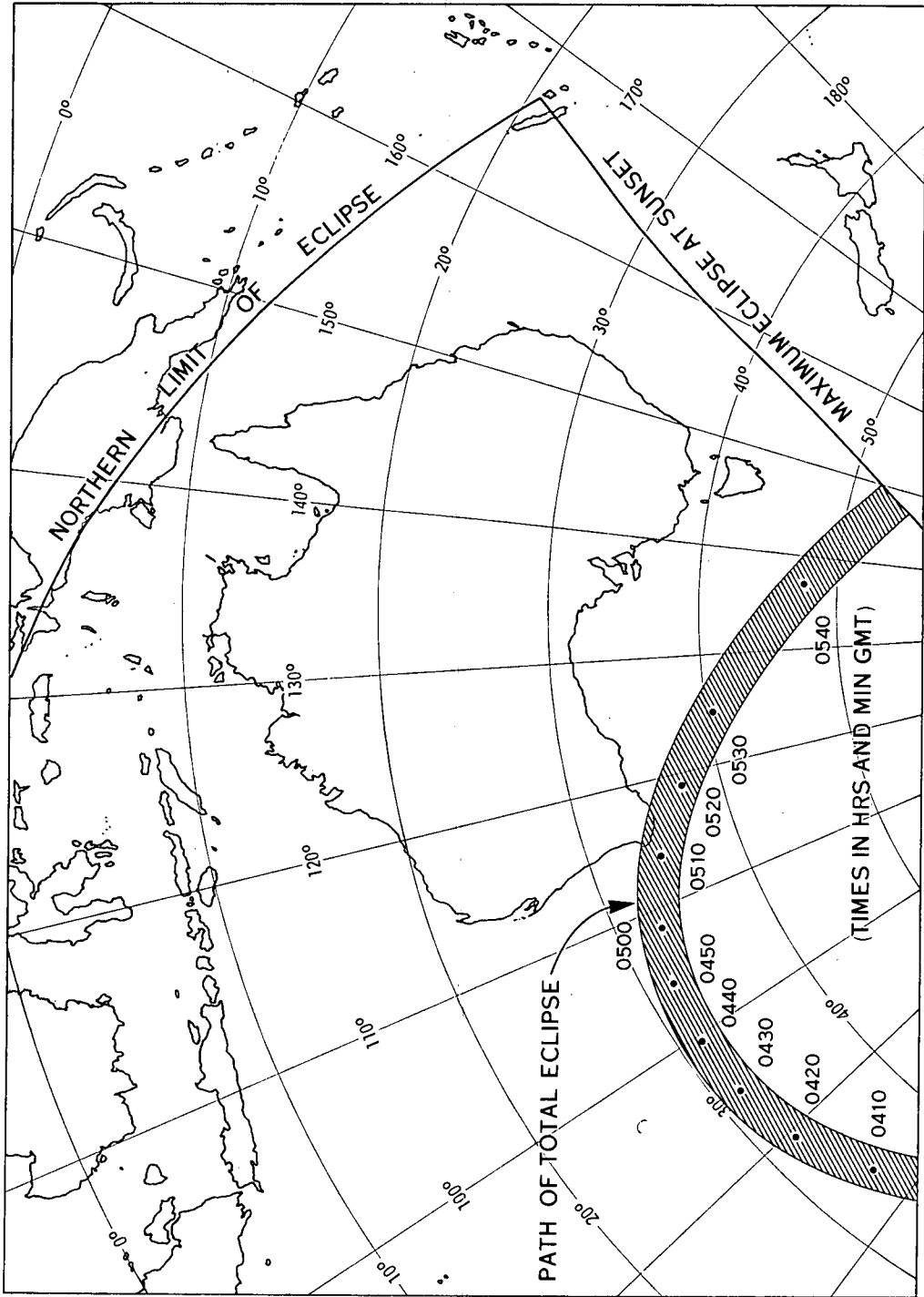


Fig 1 Path and extent of solar eclipse in the vicinity of Australia on 20 June 1971 (adapted from US Naval Observatory, 1971).

Table 2 Fractional loss of daily clear sky global radiation resulting from the eclipse (at stations with pyranometer traces relatively undisturbed by cloud).

Station	Decrement
Albany	0.18
Darwin	0.02
Halls Creek	0.06
Longreach	0.02
Oodnadatta	0.07
Pearce	0.19
Port Hedland	0.17

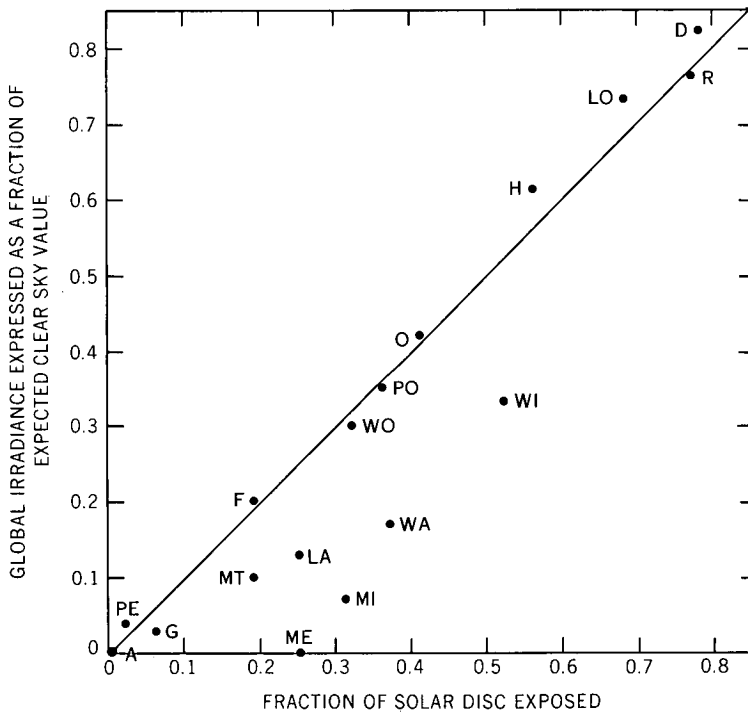


Fig 2 Global irradiance at the middle of the eclipse expressed as a fraction of expected clear sky global irradiance, versus the fraction of solar disc area exposed. Letters indicate station names as listed in Table 1.

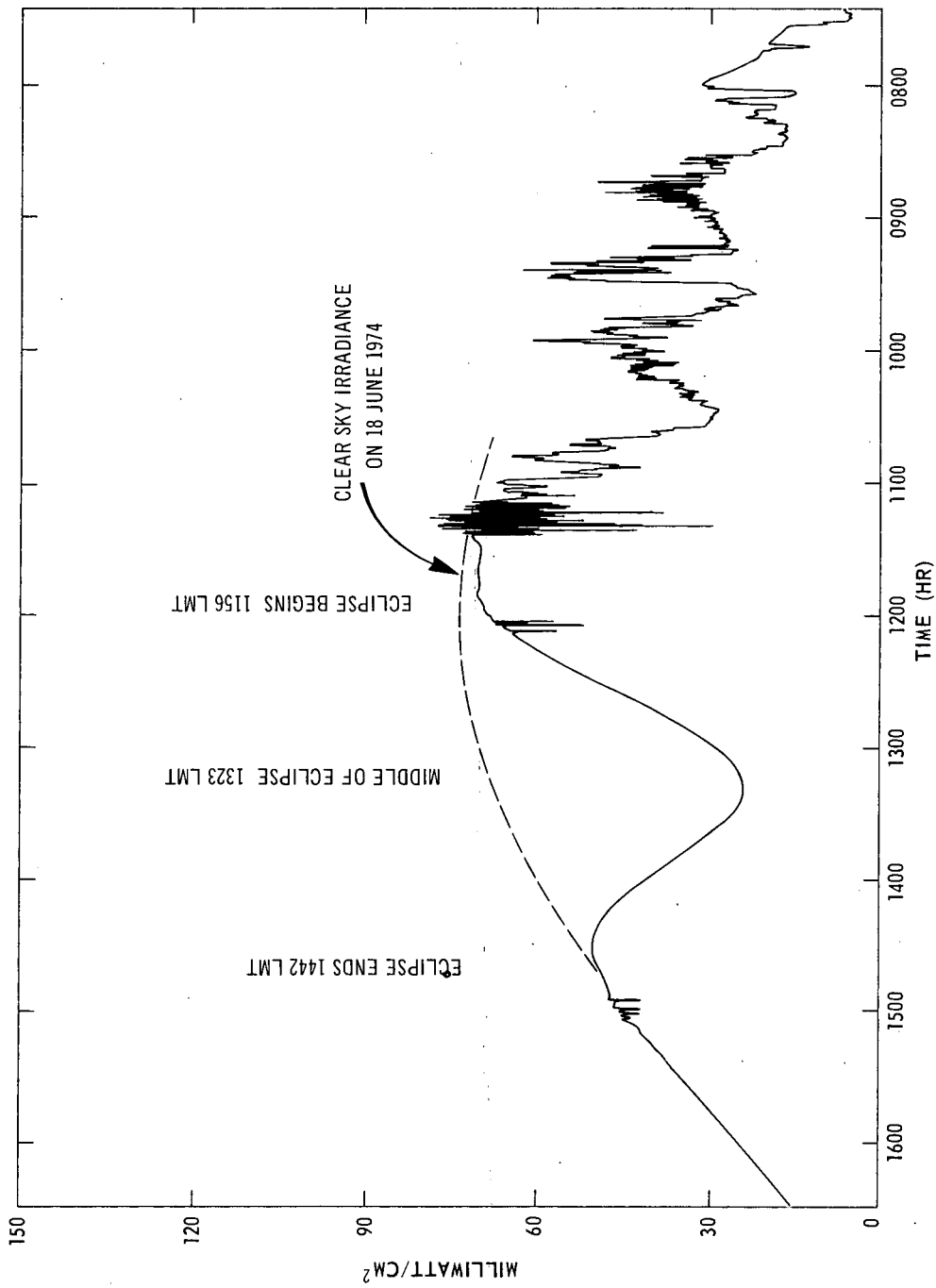


Fig 3 Pyranometer record at Port Hedland on 20 June 1974. Time proceeds from right to left.

The effect of the eclipse on the daily total of solar heat input to the Australian continent for 20 June is not large; the loss of daily total global radiation represented by the decrements in Table 2 has an average value over the continent of about 8%. For comparison the daily loss of solar heat input due to typical cloud cover over the continent can be computed from sunshine hour statistics and an empirical relationship between sunshine hours and daily global radiation such as given by Hounam (1963). An average value so computed is 17%.

## REFERENCES

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