Study of Erythemal Dose Variation and Exposure time for different UV-B Dose levels at Indian mainland and Antarctica.

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ABSTRACT

The measurements of solar Ultraviolet – B radiation intensities in the form of Minimum Erythemal Doses per hour (MED/Hr) are repeated here for different locations on Indian mainland and at Indian Antarctic Station Maitri. The intercomparison of these intensities in their diurnal variations shows that the time duration of particular dose falling continuously at different locations and different seasons is different.

INTRODUCTION

The human skin is well known to be affected by Solar Ultraviolet – B (UV-B) radiation [1]. The solar UV-B radiation at any location, for cloudless sky conditions, depends on the solar zenith angle, column ozone content, and column aerosol content as well the altitude of the observation site [2]. After the detection of ozone hole over Antarctica the worldwide monitoring of solar UV-B became very important and in this context. National Physical Laboratory, New Delhi has been engaged in monitoring the solar UV-B radiation levels at different locations in India and at Antarctica. For any biological process which gets affected by UV-B radiations, the dose amount and the time for which this dose is continuously falling is very important to raise the defense against it evolve the recovery mechanism. It is in this context the present study is important to the UV-B dose magnitude and their corresponding exposure times at different locations are studied.

INSTRUMENTS USED

For this purpose one of the instrument used has been UV-B Biometer. This instrument measures the radiation in the wavelength band 280 – 340 nm using a broadband filter. The response spectra of the detector used matches with the Erythema action spectra [3] as shown in fig 1.

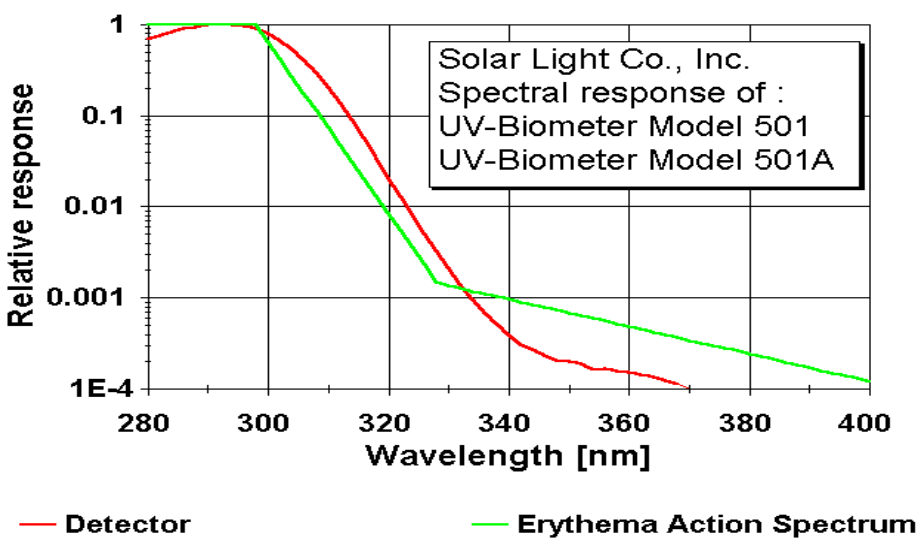

Fig. 1 Comparison of Erythema action spectra and the detector response showing the appropriateness of the UV-Biometer for Solar UV-B measurements

The detector output after convolution with erythema action spectra is converted in the form of minimum erythemal dose per hour (MED/Hr) which is defined as the UV-B radiation dose which after falling continuously for one hour starts damaging the human skin. For white skin it is defined as 5.83 microwatt per cm^2 falling continuously for one hour. The instrument has been deployed at different locations on Indian mainland and at Antarctica at different time and during different years in different campaigns to study the relative MED characteristics at these locations.

DATA ANALYSIS AND RESULTS

The data from different locations is analyzed to see the relative rate of change of MED during day time, from morning to noon, to see how fast/slow MED changes from morning to noon, time, in different seasons and to asses the continuous exposure time for different MED levels at these locations. As a typical case the measurements at Delhi, Leh, Hanle and Antarctica are shown in fig 2. The local noon peak time differs for Indian mainland and for Antarctica as at Indian Antarctic station Maitri, local noon is at 11:15 hrs. GMT (GMT is taken local time at Maitri). The diurnal peak is highest at Hanle followed by Leh, Antarctica and Delhi. The local noon maximum at Delhi is diminished by summer dust from Rajasthan blown over to Delhi during local summer.

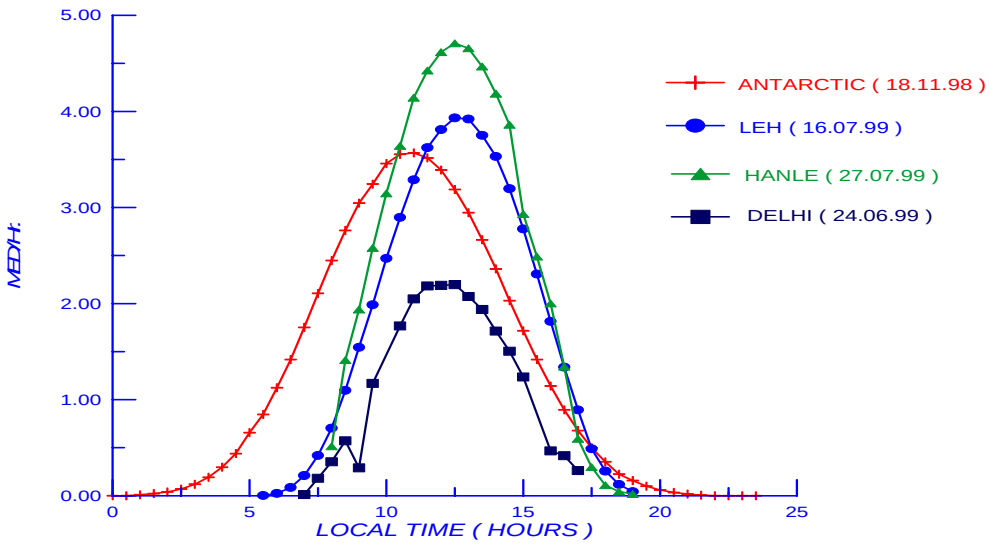

Fig. 2 Diurnal variation of Solar UV-B radiation intensities in MED/Hr. at different locations

It is found that there is a substantial variation in the rate of increase in MED at different locations and this rate of increase in MED during day time is maximum at Hanle, a location in Ladakh at high altitude (4.5 Km. above mean sea level) in central Himalayas and is found to be 0.9 MED increase per hour. This increase is even higher than that of at Maitri, Antarctica which is 0.5 MED per hour increase. The increase rate at Delhi during summer period was found to be 0.7 MED per hour and during winter it is found to be 0.3 MED per hour. At other locations in India this rate increase is found to be in between 0.2 to 0.9.

The time duration during day time for which the MED values remained continuously above 1.0 level at Antarctica was found to be maximum 10 hours during low column ozone and cloud less periods. The time duration for MED values remaining above 2.0 was found to be 7 hours and for MED values above 3.0 was found to be 4 hours. The time duration for MED values remaining continuously above 1.0,2.0,3.0 and 4.0 at Hanle was 9,7,6 and 5 hours respectively. For Delhi summer period the time duration for MED values remaining continuously above 1.0, 2.0 and 3.0 was 8,5 and 2 hours respectively and for winter period the time duration was found to be 3.0, 0.0 and 0.0 hours. The conclusion is drawn from the above analysis

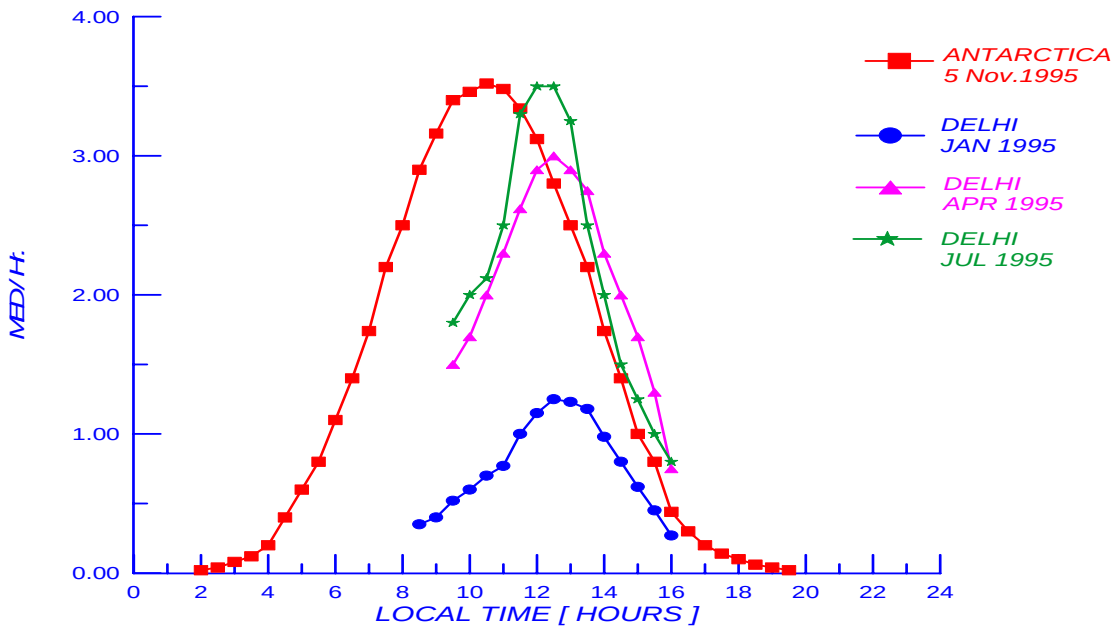

Fig 3 Comparison of UV-B Dosage at Antarctica and over Delhi. The Antarctica values are a yearly maximum and are compared with Delhi values for different seasons

that UV-B doses are higher in magnitude as well as in time duration during Delhi summer periods and at Hanle compared to Antarctica even during the low column ozone content periods. In the light of this analysis the safer limit of UV-B dose for Indian skin is also defined considering the average annual MED scenario over India and over higher latitudes. For example the annual average of daily maximum (local noon time value) of MED/Hr for Delhi has been estimated to be around 2.0 MED/Hr. Hence the Minimum Erythemal Dose per hour for Delhi is twice compared to that defined for which skin. This means that the Indian skin does not get affected by UV-B radiation falling with the hourly dose rate of 2.0 MED/Hr. Similarly the safe UV-B dose rate for other locations on Indian mainland can be assessed from the data collected for complete one year and then taking annual average of it.

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