SOLAR ULTRAVIOLET RADIATION IN AUSTRALIA : RESULTS FROM NETWORK MEASUREMENTS AND THEIR USE IN PUBLIC EDUCATION

C.R.Roy and H.P.Gies and K.H.Lokan
Australian Radiation Laboratory (ARL), Yallambie, Victoria 3085, Australia.

Abstract

Growing evidence of global depletion of stratospheric ozone has given additional support to the ultraviolet radiation (UVR) network established by ARL in Australia and Antarctica. The data produced is necessary to increase our knowledge of atmospheric change, human health studies and for public education.

Introduction

Australia has high levels of ambient UVR and the highest incidence rates for both non-melanoma skin cancer and cutaneous malignant melanoma in the world because of poor protection practices. These facts together with the widespread publicity given to the annual large-scale ozone depletion in Antarctica have made Australians increasingly concerned about exposure to solar UVR.

The ARL has been making spectral measurements of UVR in Melbourne since the mid 1980s. In addition broadband measurements are now made at a total of seventeen locations in Australia and at the Australian bases in Antarctica (Fig.1). The aim of these measurements is not primarily to determine long-term trends in UVR but to provide data on ambient UVR and input into epidemiological studies as well as information to help educate the public about the dangers of overexposure to UVB.

Ozone depletion continues to be of major concern in Antarctica, to the adjoining countries in the mid-latitudes of the Southern Hemisphere and to the globe as a whole. Following the breakup of the hole, population centres can be exposed to higher ambient UVR as a result of ozone transportation and dilution effects.

Figure 1 Measurement sites.

Experimental method

The radiation calibration of the network is underpinned by the spectroradiometer (SRM) system at Yallambie (38°S)[1]. This PC-controlled system incorporates a Spex 1680B double grating monochromator with an integrating sphere input optic. The noise equivalent spectral irradiance at 300nm is less than 1 $\mu W\ m^{-2}\ nm^{-1}$. Global and diffuse horizontal terrestrial UVR over the spectral range 280-400nm is measured at 1nm steps with a bandpass of 1nm on cloud-free days. Radiation calibrations are performed in-situ using a calibrated 1000 W quartz halogen lamp.

The broadband measurement system has four radiometers each responding to the regions of the solar radiation spectrum indicated: solar radiation [0.285-2.8 µm], solar UVR [295-385nm], UVB [280-315nm] and erythemal UVR [280-340nm].

Ideally an Australian network of 5 or 6 spectroradiometers would provide data to satisfy most research interests. However, available resources dictated a network comprising a permanent SRM in Melbourne, a broadband network and a portable SRM for the regular field calibration of the broadband detectors.

Results and Discussion

Solar UVR

Prior to discussing solar UVR protection it is necessary to have knowledge of the levels of ambient UVR for the particular location as to a large extent this will determine strategies. Data is expressed in terms minimal erythemal doses (MEDs) where one MED equals 200 J m^{-2} when the solar spectra is weighted by the CIE erythemal response function[2]. The radiation environments of Brisbane (27.5°S), Perth (32.0°S) and Hobart (42.8°S) are shown in Figure 2. In January Perth can have up to 35 MEDs per day, this is higher than Darwin (12.4°S) because of the considerably lower cloud cover at that time of the year. Hobart, which is the most southern of the Australian capital cities can have more than 20 MEDs per day in summer. In winter levels are much lower and would rarely exceed 10 MEDs even in the tropics.

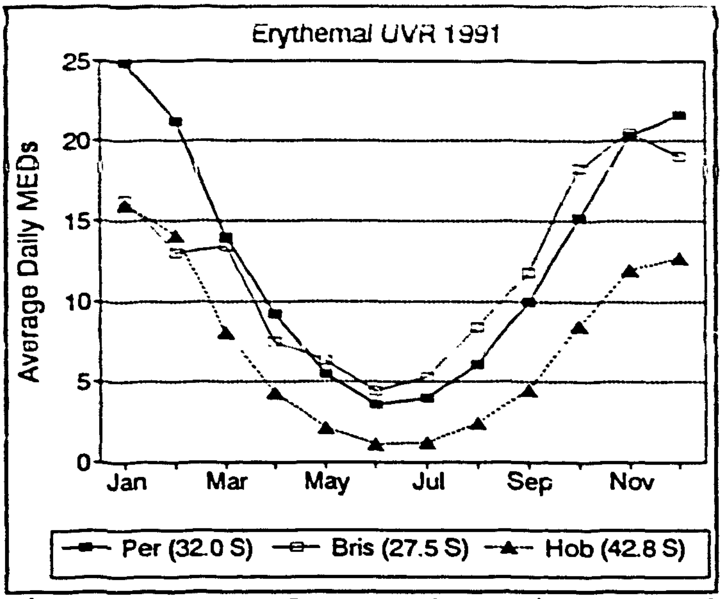

Figure 2 MEDs for Perth, Brisbane and Hobart in 1991.

The overall shape of the curves is due largely to the influence of solar zenith angle (SZA) and to a limited extent ozone. The effect of cloud is quite marked with Perth, through summer, having more UVB than Brisbane because of the clearer skies. This is reversed through winter and spring with Brisbane, which is at the lower Latitude having consistently higher UVB. However, it should be noted that even Hobart, which is located the furthest south of the major cities has high UVB in summer and this dictates active educational programs to reduce personal exposure to UVB.

Ozone depletion

The reality of Antarctic ozone depletion has widespread implications for solar UVR levels not only in Antarctica, but in the southern mid-latitudes where the effects of ozone transport have been reported[3,4] and dilution effects may be expected. A recent analysis of TOMS data by Stolarski et al.[5], found that for the period late 1978 to early 1990 the total ozone column between 65°S and 65°N decreased by 3%. A summary of the ozone trends is given in Table 1.

Table 1
Ozone (percent per decade) trends from the analysis of Stolarski et al.[5]

Period	45°S	Equator	45°N
Dec-Mar	-5.2	+0.3	-5.6
May-Aug	-6.2	+0.1	-2.9
Sep-Nov	-4.4	+0.3	-1.7

The major points which emerge from this analysis are firstly that very little ozone depletion has occurred in the equatorial region, secondly at 45°N the greatest depletion occurs during winter when solar UVB is at its lowest and thirdly at 45°S significant depletion occurs all year with summer only slightly less than winter. This can be explained by an ozone dilution effect subsequent to the ozone hole breakup. It seems certain that the mid-latitudes of both the northern and southern hemispheres will experience elevated solar UVB in the coming years.

Personal dosimetry

Polysulphone film badges have been used to quantify personal exposure to solar UVR[6]. Fig.3 shows results from a recent study of indoor, outdoor and retired workers. Results suggest that exposures of up to 30% of the ambient UVR are possible. Through studies of this type, knowledge is gained on the amount and pattern of exposure from routine activities and this can then be applied in the design of educational campaigns to modify outdoor behaviour and reduce UVR exposure.

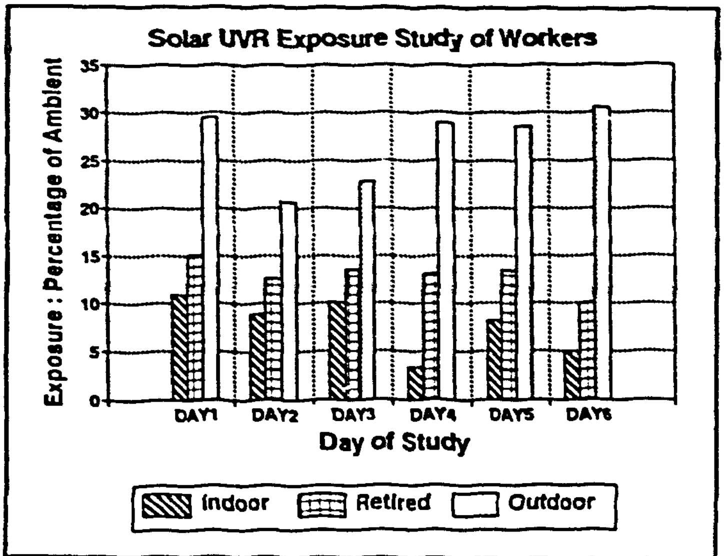

Figure 3 Exposure of groups of workers.

Protection

The above discussion indicates that exposures of up to 10 MED per day are possible and behaviour modification and personal protection must decrease this to less than 1 MED. We have shown that clothing[7], wide-brim hats, sunglasses and sunscreens can readily achieve this target.

Educational campaigns

Since 1981 the Anti-Cancer Council of Victoria has run a national educational campaign. The two aspects to skin cancer control-prevention and early detection-are both embraced by what is now a nationally coordinated program.

The Australian Radiation Laboratory, using data from its National measurement network, provides to the media a daily chart of UVB for the capital cities in each state. These are broadcast with the weather on the nightly television news report (see Fig.4). This 12-15 second time slot provides a unique opportunity to reach a large audience and to help educate the public about UVR and the link or otherwise to ozone, cloud cover and daily temperature. This has generated considerable public interest.

Many schools and community groups are taking a greater interest in minimising UVR exposure and a variety of initiatives have emerged from the enforced wearing of hats in school grounds, planting of more shade trees in open areas and changes to the hours that schoolchildren spend outdoors.

Evaluation of programs

Evaluation of a prevention program measures initially a change in knowledge and attitudes, then a change in behaviour and eventually a change in the incidence and mortality rates of skin cancer.

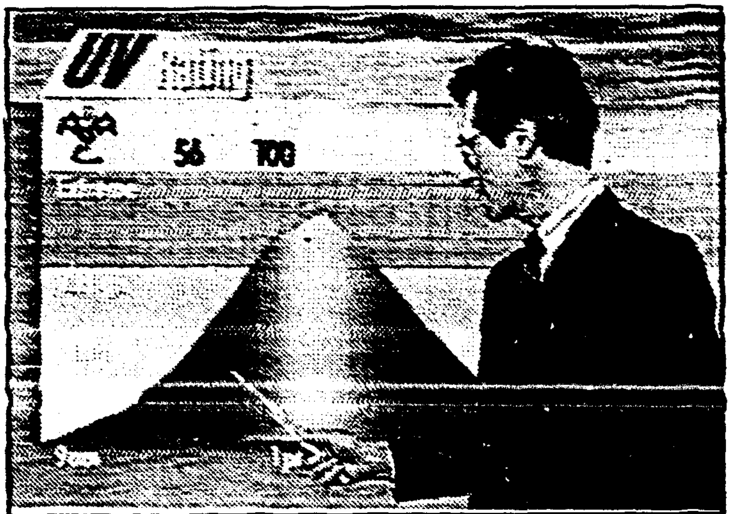

Figure 4 Presentation of UVB chart on Melbourne television

With regard to skin cancers it is still too early to evaluate the effectiveness of the educational campaigns. However it has been reported that excised cutaneous malignant melanomas are becoming thinner which indicates that they are being found earlier which in turn results in a higher 10 year survival rate.

Conclusions

Educational programs aimed at both the work force and the public have succeeded in creating an awareness of the dangers of overexposure to ultraviolet radiation. Although products have been available to provide good personal protection the consumer has not always been provided with the information to enable a proper choice. The use of sensible protection can help to achieve an order of magnitude decrease in the exposure to solar ultraviolet radiation.

References

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