Measured Occupational Solar UVR Exposures of Outdoor Workers in Victoria in Winter

Peter Gies[1], Kimberley Dunstone[2], Kerryn King[1], Jen Makin[2], John Javorniczky[1] and Martin Allen[3]

1 Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)
2 Cancer Council Victoria Centre for Behavioural Research
3 University of Canterbury

Abstract. In August 2011, ARPANSA and the Cancer Council Victoria Centre for Behavioural Research conducted a pilot study of personal ultraviolet radiation (UVR) exposures of outdoor workers in Melbourne and its surrounding areas in winter. The participants were four groups of outdoor workers (building and construction industry workers, physical education teachers, workers at the alpine ski fields in Victoria and farmers) and the UVR exposures were measured using electronic UV dosimeters. In late August, the weather was unusually sunny and as was subsequently realised, ozone reached very low levels above much of Southern Australia. This affected the measured daily ambient total UVR, which increased substantially from the early August levels of 4 to 10 Standard Erythemal Doses (SEDs) per day to approximately 20 SEDs per day during the last week of August. The effect on the measured UVR exposures of the various subjects participating in the study was also substantial, particularly those subjects participating in late August, where measured personal UVR exposures were approximately twice those of participants in early August. The UVR exposures of early August are more typical of normal winter conditions while those of late August are anomalously high due to a substantial low ozone event and clear skies (Gies *et al*., 2013). The results highlight the need for year-round sun protection for Victorian workers who spend much of the working day outside, and the importance of systems to warn the public when UVR levels are unseasonally high.

Ambient solar UVR and Exposures Studies

Australia has very high levels of solar UVR along with an outdoor lifestyle, which results in high exposures to UVR and subsequently high skin cancer rates (International Agency for Research on Cancer 2010). At risk groups are young children, as exposures in early life are very important and outdoor workers, given they spend long periods outside in the sun. A number of studies have been carried out to quantify the UV exposures of different groups of outdoor workers (Gies et al 2009, 2003). Outdoor workers are meant to be provided with personal protective equipment (PPE) in order to protect them from harmful UVR when outside (RPS12 ARPANSA), however while larger companies do provide PPE to their workers, compliance amongst smaller companies and the self-employed is often less rigorous. This was also true for this study, with the building and construction industry workers provided with PPE and required to wear it, as were the ski field workers. The physical education teachers were not provided with PPE but often provided their own while the farmers had hats but as a group were often less sun aware.

The electronic UV dosimeters used in this study (Allen et al 2005) were calibrated against a Bentham spectro-radiometer on the roof of the ARPANSA laboratory with a calibration traceable to the CSIRO National Measurement Institute. Each subject wore 2 UV dosimeters, usually one on the chest, the other on the wrist. Ambient solar UVR data for Melbourne is measured by a Solar Light UV Biometer located on the roof of the ARPANSA laboratory.

Two UV dosimeters were dropped off to the participants by arrangement and then collected after a week to 10 days, depending upon availability of both participants and CCV/ARPANSA staff. The UV dosimeters were programmed to run for a much longer time period in case of delays in collection, but only the data for the subject for the relevant days was utilised).

Figure 1. One of the building/construction workers wearing 2 white UV dosimeters, one on his wrist, the other on his helmet. As it was compulsory to wear the helmet on the work site, it was chosen as a UV dosimeter site.

The Low Ozone Event of August 2011

Low ozone has been recorded over southern Australia previously, resulting in increased levels of solar UVR above Melbourne (Roy et al 1990), but its source on that occasion was ozone depleted air moving northwards after the breakup of the ozone hole in November/December. In August 2011 the measured UV Index at a number of Southern cities shown live on the ARPANSA website were seen to be well above the long-term average expected. A check of satellite ozone confirmed ozone values were below average, with resulting higher levels of UV index, well above the seasonal average by approximately 33 to 40% depending upon the location. The higher UV levels occurred firstly in Perth, then Adelaide, Melbourne and Canberra and subsequently Sydney and to a lesser extent (due to more cloud cover) in Newcastle and Hobart. Even though it was winter the low ozone event coincided with clear skies and sunny weather, although this varied somewhat by location.

The cause of the low ozone over Australia in August 2011 is covered in more detail elsewhere (Gies et al 2013) but the major causal factor was an intense anticyclonic ridge that extended over Australia during late August.

While there was also some influence from the transport toward Australia of ozone-poor air from the region of the stratospheric polar vortex, the major influence was from the ridge drawing in ozone-poor air in the lower stratosphere from subtropical latitudes. Low ozone events have been reported in the scientific literature previously, both in the Southern as well as the Northern Hemisphere (Brinksma et al 1998, Stick et al 2006) with subsequent effect on solar UVR levels. However, this 2011 event was more significant, where atmospheric processes produced a change in ozone levels over southern Australia on a continental scale and of considerable duration. The fact that a study on UVR exposures was taking place in an around Melbourne at the time allowed the assessment of the possible effects of the low ozone and increased solar UVR on a group of workers and by extrapolation possibly to the population of Southern Australia.

Measured Worker UVR Exposures

The pilot study on outdoor worker UV exposures commenced on the 2nd of August with 5 building and construction workers and finished on September 1st. In all 26 workers participated, 7 building and construction workers, 6 PE teachers, 7 farmers and 6 alpine ski-field workers, of which 24 provided UV data readings successfully. In 3 cases, only 1 of the 2 dosimeters used on each subject provided data. While 26 participants is not a large number, the strength of the study was that in all the 339 days of UV data readings were recorded, providing a substantial amount of data and good information on patterns of UVR exposure for many of the participants. The measured daily total UVR for Melbourne in August increased from 4-10 SEDs/day early in August to 18 SEDs/day later in August. Overall the measured UVR exposures of the subjects participating in early August were lower than were those in late August (see Figure 2).

Worker Type	Total Exposure (SEDs) Daily	Weekly
Building/Construction	0.2 – 4.3	1 - 17
PE Teachers	0 – 7	0.2 - 15
Farmers	0 – 10	0.1 - 24
Skifield Workers	0 – 10	7 - 43

Table 1. Measured daily and weekly UVR exposures in SEDs for the four groups of outdoor workers. An exposure of 2 SEDs will cause sunburn in people with Skin Type 2.

As a group, the overall average UVR exposure of all of the subjects was 13.5% of ambient solar UVR. The maximum UV exposure recorded by any subject in a day was 10.4 SEDs on the 24 August, a clear sunny day when ozone was at its lowest. However, daily UVR exposures of 7 and 9 SEDs were received by some PE teachers in the first half of August when ozone levels were normal. These results indicate that there is a need for year-round sun protection for Victorian outdoor workers.

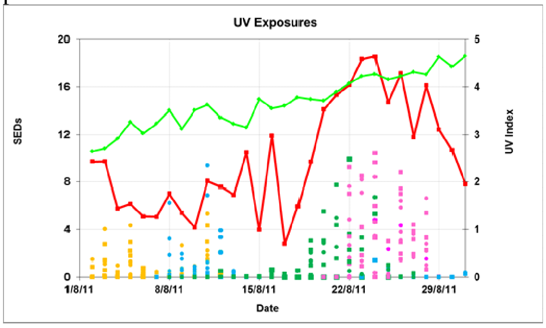

Figure 2. The daily UV Index (green line) and daily total UVR in SEDs (red line) for August 2011 in Melbourne. The daily UVR exposures in SEDs for the participants are also shown. The different groups are building and construction workers (yellow dots), PE teachers (blue), farmers (green) and alpine workers (pink).

As a result of the low ozone event across much of Southern Australia, the resultant higher UVR levels would have led to exposures of the Australian population at a time of year when people are vulnerable and susceptible to overexposure. Changes to the way the UV Index is reported by utilizing ozone forecasts to highlight such anomalous events in advance in the future should allow the public to be warned in advance.

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