UV exposure on New Zealand ski-fields

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Abstract. UV exposures measured during a measurement campaign at Mt Hutt Skifield in 2003 are compared with those from a more extensive campaign in 2005. The results from the skifield are also compared with those received during a round of golf in the summer at nearby courses. The overall conclusions are similar to those from the 2003 study. The UV exposures are sensitive to the location of the sensor, and the total dose received during skiing is similar to that received during a round of golf in summer.

Introduction

UV dosimeter badges were recently developed to monitor personal exposures to UV radiation. They comprise a miniaturised detector designed to measure erythemally-weighted UV radiation. The sensing element to achieve this weighting is an aluminium (27%) gallium nitride (AlGaN) photodiode. With these detectors, no further optical filtering is required. The detector is housed in a weatherproof PTFE enclosure, with a front surface machined to provide a cosine response. When located on a horizontal surface, the sensor therefore measures erythemally-weighted irradiance, which is proportional to the UV index (1 unit of UVI corresponds to 25 mWm^{-2} of erythemally-weighted UV irradiance). The dosimeter is powered by a lithium coin cell battery, and the complete assembly has diameter 35 mm and thickness 13 mm, and weighs approximately 20.7 grams, so can easily be pinned to clothing, or attached via Velcro straps. Subjects can therefore wear the devices unimpeded. The data logging is controlled by a microprocessor, which allows data to be sampled at time intervals as short as 4 seconds. There is sufficient on-board memory and battery capacity to store several days of data. At the end of a campaign, the data can be downloaded to a computer for further analysis. Calibration is achieved by regressing the output of the detector against concurrent erythemally-weighted UV measured by research grade radiometers maintained by NIWA, whose calibrations are traceable to NIST, through annual field calibrations at Lauder.

The dosimeters were designed for behavioural studies involving school children [*Wright et al.*, 2005]. In the present study, samples were used to monitor UV exposure during periods of skiing and other outdoor activity. The first such study was carried out in the winter of 2003 at Mt Hutt ski field, using a single dosimeter worn on the lapel. The methodology and results of that study have been published elsewhere [*Allen and McKenzie*, 2005]. Briefly, it was concluded that:

1. The UVI on the ski-field was 20-30% greater than at sea-level.
2. Over the period of the ski season there are rapid increases in peak UVI.
3. UV intensities were often significantly greater than on horizontal surfaces.
4. Peak UV intensities during these ski days are less than at sea level in summer.

The first study was limited to a single anatomical site on one subject (M Allen). Here we describe the results of a follow-up study that included more sensors located at different anatomical sites on several individuals. The study was also supported by having similar sensors mounted horizontally at the top and bottom of the ski field, and at a low altitude site of similar latitude.

As with the first study, the second study, in 2005 was carried out over two predominantly cloudless days of skiing at Mt Hutt Ski field during September and October. The dosimeter badge deployment on the second day is shown in Table 1.

Instrument	Position	Person / Location
Badge 1	Front Head (on beanie)	Martin Allen
Badge 2	Right Arm	Martin Allen
Badge 3	Right Chest	Martin Allen
Badge 4	Right Arm	Ski Instructor #1 (Claudine)
Badge 5	Right Arm	Ski Instructor #2 (Dave)
Badge 6	Horizontal	Summit (2086m)
Badge 7	Horizontal	Base (1590m)
YES Meter	Horizontal	Kyle St, Christchurch (30m)

Table 1. Badge deployment on 9 October, 2005.

Although 2005 was a poor skiing season, there was recent fresh snow coverage at Mount Hutt Ski-Area on both skiing days: 21 September and 9 October, with slightly better conditions on the latter day.

Results and Discussion

Results from the second campaign in 2005 were quite comparable with those from the campaign in 2003. There were significant differences in UV at different anatomical sites. The arm and cap sites received similar peak UV intensities, but the doses for the cap site were 40% greater. The chest site, which had been used in the 2003 study, received approximately 80-85% of the peak values at other two sites. Sample results of dosimeter measurements are shown in Figure 1. Results for the two ski days in 2005 are

compared with those for 2003 in Table 2.

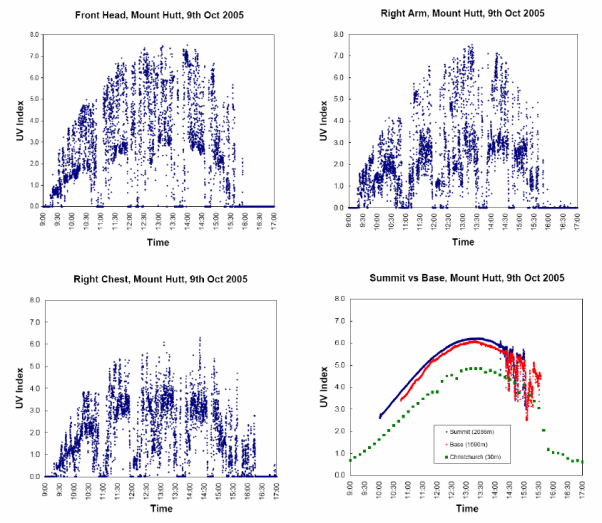

Figure 1. Measured UV intensities on 9 October at Mt Hutt and at Christchurch.

The peak UV 'envelopes' were very similar for 'Front Head' and 'Right Arm' badge positions; whereas the 'envelopes' the 'Right Chest' badge position was significantly less than 'Front Head' and 'Right Arm' positions. The total dose for 'Front Head' badge position was significantly higher than for 'Right Arm' and 'Right Chest' positions. The envelope were very similar for Martin Allen and both ski instructors, and there was only a small difference between the UV at the Summit of the mountain (2048m) and the Ski-Field Base (1590m).

	Peak irradiance UVI	Peak UVI_n	Daily Dose (SED)
12 Sept 2003	4.3	6.1	10.6
15 Oct 2003	6.9	8.0	19.7
21 Sept 2005	4.6	6.1	12.1
09 Oct 2005	6.2	7.5	16.3

Table 2. Peak UV and daily doses measured at Mt Hutt ski field on the four days. In each case the dose was measured over an approximate 6 hour period between 10am and 4pm.

As in the previous study, the UVI values at Mt Hutt in 2005 were approximately 30% more than at sea level.

Finally, we compare the UV dose received while skiing with that received playing golf in the summer at nearby locations (Hororata, and Christchurch, both on the Canterbury Plains at latitudes near 43.5°S). The peak UVI received playing golf was close to the peak value measured on a horizontal surface in Christchurch on the same day. The UV exposures during these rounds of golf were comparable with those from skiing, but were less than 30% of the UV dose (~70 SED) incident on a horizontal surface throughout a summer's day at this latitude.

	Peak UVI	Daily Dose (SED)
23 Jan 2006, Golf at Hororata (12:00 – 15:30)	9.8 9.6	16.4 8.9
27 Jan 2006, Golf at Coringa, ChCh (12:00-16:30	9.6 9.3	18.4 9.6

Table 3. Peak UVI and daily doses measured at low altitudes for golf activities in summer. The first value is for the sensor on the cap, the second is for the sensor on the arm.

Conclusions

The results are broadly consistent with the 2003 study.

The anatomical sites on the head and arm receive larger doses than the chest site which was used in 2003.

The peak UVI values are ~30% more than at the sea level site.

The UV dose during skiing was comparable with that received during a round of golf in the summer.

Acknowledgements
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References

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