EXTREME UV INDEX AND SOLAR EXPOSURES AT PLATEAU ROSÀ (3500 m a.s.l) IN VALLE D'AOSTA REGION, ITALY

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INTRODUCTION

The present study shows the results of a field campaign to assess summer personal exposures of skiers at the Alpine site of Plateau Rosà (45.9°N, 7.7°E, 3500 m a.s.l.), in Valle d'Aosta region, Italy. The compelling reason was that, at the above site, particularly in summer, the human head is exposed to significant solar UV exposures due to both altitude and snow reflection.

MATERIALS AND METHODS

Plateau Rosà (Fig.1) is an alpine ski site, located on the Swiss-Italian border, where summer skiing is actively practiced. In addition, the site hosts an international scientific observatory. A field campaign with 15 volunteers, using polysulphone (*PS*) and polyphenylene oxide (*PPO*) dosimeters (Fig.2) attached to their cap [1], was carried out on 12 July 2011 to evaluate personal erythemal exposures (*PEE*) and exposure ratios (*ER*). *ER* is the ratio between *PEE* and the ambient dose as measured by a radiometer (UV-S-AE-T Kipp&Zonen broad-band radiometer belonging to ARPA Valle d'Aosta [2]) during an identical exposure time. The *PPO* badges were held on continuously from 9.00 LT (local time) to 13.00 LT whereas the *PS* dosimeters were changed at chosen times to avoid saturation (*PS-A* from 09:00 LT to 10:30 LT; *PS-B* from 10:30 LT to 12:00 LT; *PS-C* from 12:00 LT to 13:00 LT). Horizontal calibrations were performed both for *PS* and *PPO* dosimeters measuring the changes in absorbance ΔA at 330 nm and 320 nm respectively *vs* the ambient erythemal dose *D* provided by the broad-band radiometer. The following cubic fitting equation was used:

$$D = c\left(\Delta A + \Delta A^2 + \Delta A^3\right) \cdots\cdots\cdots eq.(1)$$

where *c* (kJ m^{-2}) is a multiplying coefficient mainly dependant on solar zenith angle and total ozone.

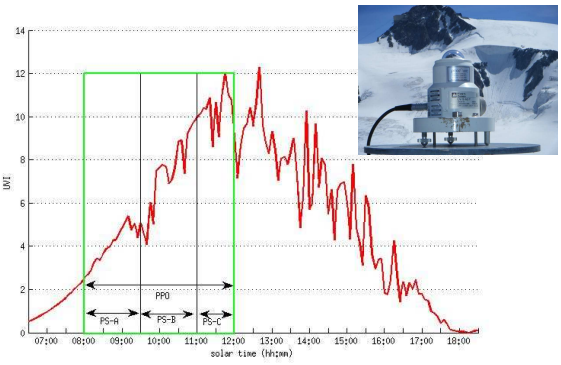

Fig.3: UVI values (red line) at Plateau Rosà on 12 July 2011. The green box indicates the time interval of the field campaign (09:00 – 13:00 LT, i.e. 08:00-12:00 solar time). Inside the green box, the time intervals when the *PS* dosimeters were changed are also shown. In the small picture, the UV-S-AE-T Kipp&Zonen broad-band radiometer at Plateau Rosà.

ULTRAVIOLET INDEX (*UVI*)

UVI [3] is a dimensionless parameter, defined as the erythemally weighted solar dose rate between 290 and 400 nm divided by 25 mW/m^2. It is frequently adopted to provide public information useful to determine the sunburn times under different individual conditions.

At middle latitudes, *UVI* can reach the value of 10 in summer; however at Plateau Rosà a maximum value of 12 was experienced during the field campaign (Fig.3).

Fig.1: The site of the field campaign as seen by Google Earth

Fig.2: The volunteers wearing *PS* and *PPO* dosimeters on their caps

PEE (SED)	*Median*	*Maximum*	*Minimum*
PPO	11.3	20.0	8.0
PS-A	4.3	5.4	2.8
PS-B	6.3	8.7	4.1
PS-C	5.3	8.7	2.6
PS-A + PS-B + PS-C	14.7	21.3	11.6

Table 1: PEE statistics for the volunteers (1 SED=100 J/m^2)

ER	*Median*	*Maximum*	*Minimum*
PPO	0.46	0.90	0.35
PS-A	0.79	0.99	0.51
PS-B	0.64	0.88	0.42
PS-C	0.60	0.86	0.33

Table 2: ER statistics for the volunteers

RESULTS

The *c* coefficients (in kJ m^{-2}) for the *PS* and the *PPO* curves were respectively 1.04±0.04 (R^2=0.94) and 13.0±0.8 (R^2=0.95). Using *eq.(1)*, *PEE* and then *ER* for each volunteer were retrieved. Summary statistics are reported in Tables 1 and 2. The total *PEE* of 14.7 SED (1 SED=100 J m^{-2}) was obtained as the median values of the sums *PS-A+PS-B+PS-C* (Table 1) for each volunteer and the value is consistent, within the uncertainty, with that obtained by *PPO* (11.3 SED).

It was also found (Table 2) that *ER* ranged from 0.33 to 0.99 for *PS* and from 0.35 to 0.90 for *PPO*.

CONCLUSIONS

Human exposure on ski-fields is consistently higher compared to other environmental conditions (e.g. rural sites [4]). The targeted population of skiers overcame the occupational Threshold Limit Value (1-1.3 SED) defined by ICNIRP for non adapted skin per 8 hours work [4]. For some skiers, exposures were similar to those received by a horizontal surface. Both *PS* and *PPO* dosimetric techniques provided lower *ERs* than those (min. 0.63 – max. 1.37) reported in a previous study [5] for spring 2006 at La Thuile-Les Suches (45.7°N, 6.6°E, 2100 m a.s.l.), in the same region. The reason could reside in the different exposures of ski slopes having different orientations towards the sun.

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