UV exposure on a ski-field at an Alpine site

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Outline

1. Why was this study performed?

-To carry out for the first time a polysulphone dosimetry experiment with skiers who are highly exposed to UV radiation.
- To collect original data of personal UV exposure in the mountainous areas of Italy.

2. What did we carry out?

Two field campaigns using polysulphone dosimetry at the Alpine ski field of La Thuile (2100m) in Valle d'Aosta.

3. Preliminary results

Several studies on UV radiation in mountainous areas have been carried out.

Few studies on personal UV exposure in mountainous areas were conducted.

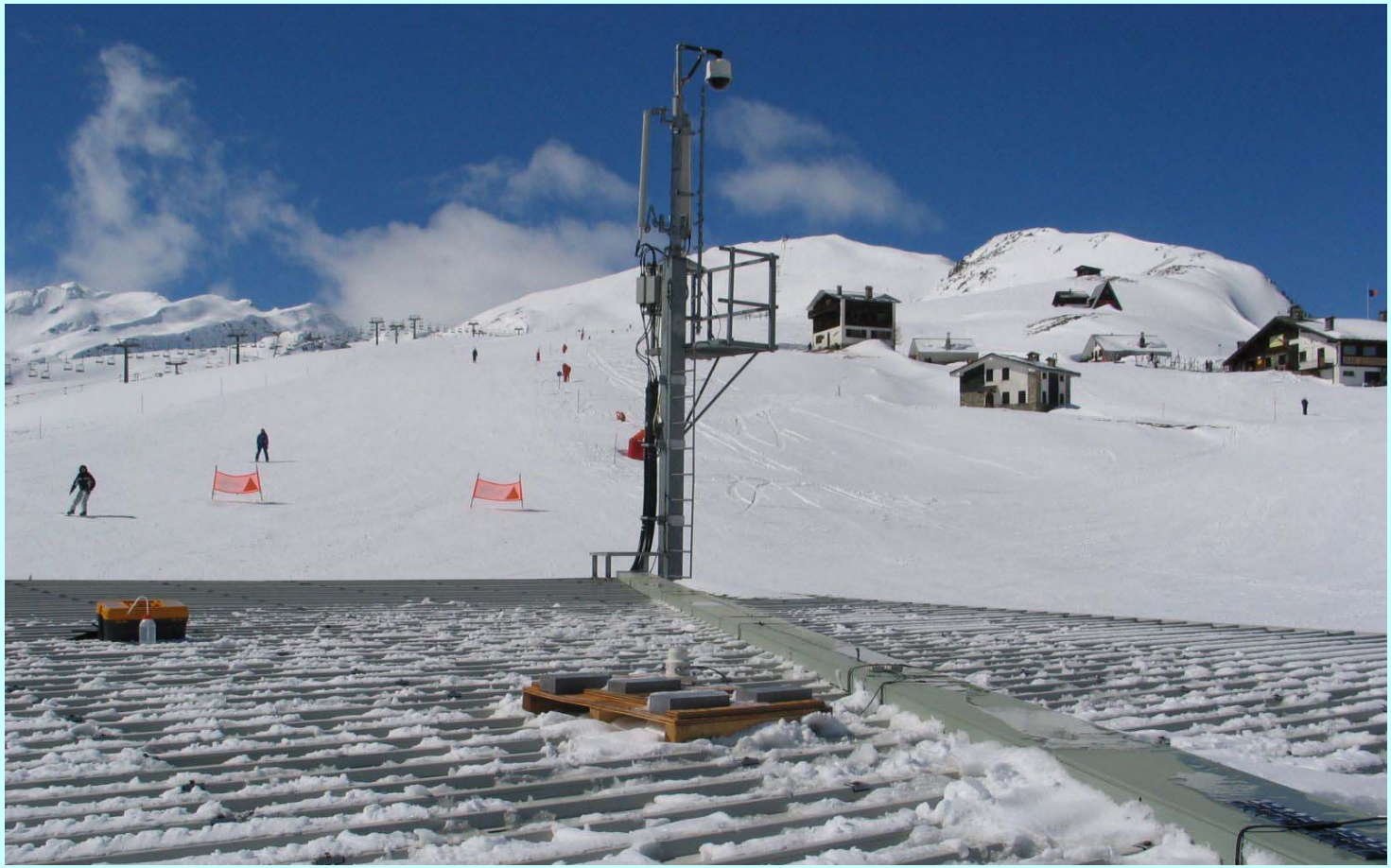
"Bacillus subtilis spore film dosimeter in personal dosimetry for occupational solar ultraviolet exposure"
M. Moehrle M. korn, C. Garble (Int. arch. Environ. Health 73, 575-580, 2000).

"Continuous Long-term monitoring of UV radiation in professional mountain guides reveals high exposure"
M. Moehrle, B.Dennenmoser and C. Garble (Int.J. Cancer, 103,775-778,2003).

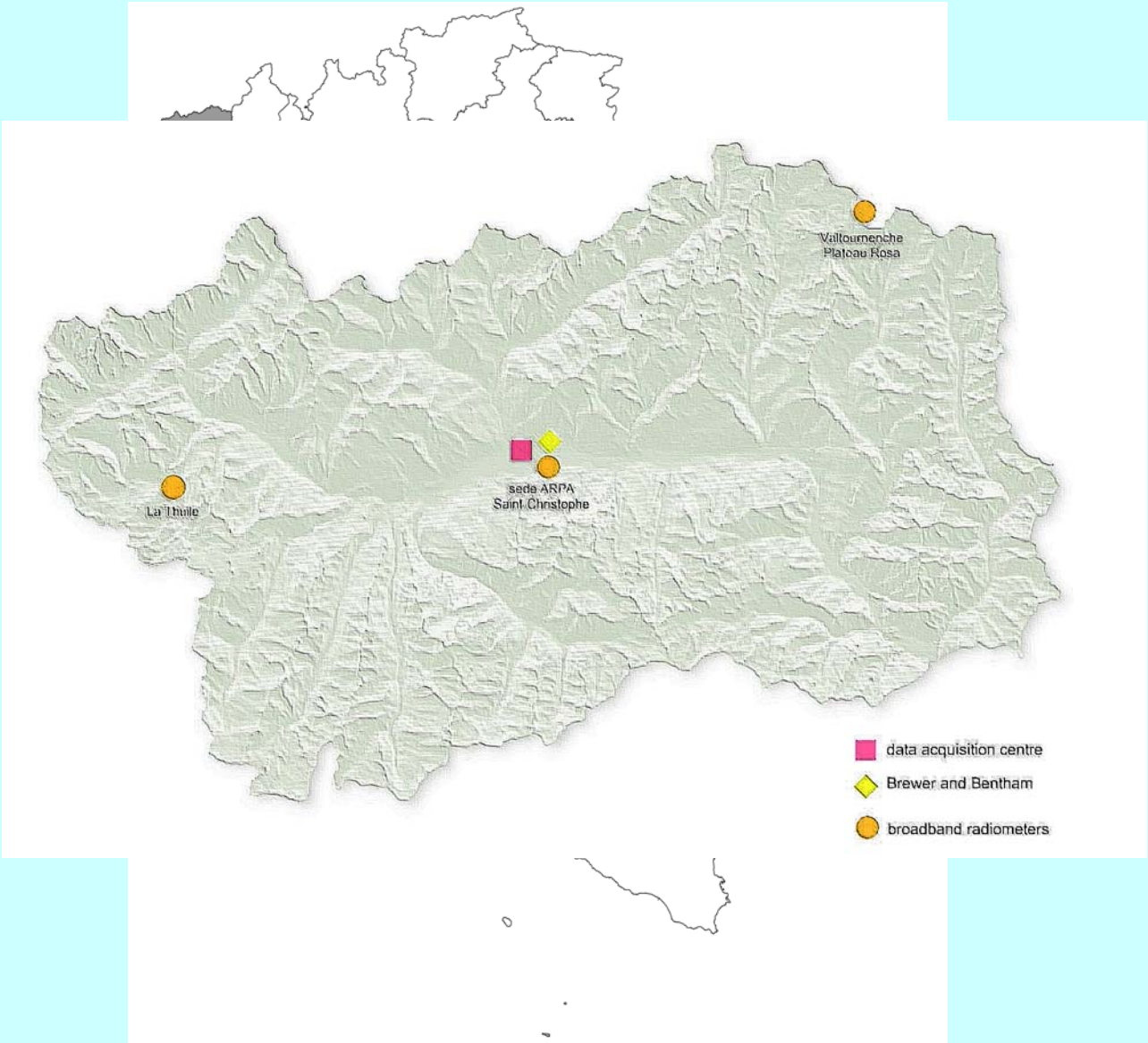
"Enhanced UV exposure on a ski-field compared with exposures at sea level"
M.Allen and R. McKenzie (Photochem. Phtobiol. Sci, 4, 429-437, 2005)

The Alps are one of the places where UV levels are the highest in Europe and tourism is leading more and more people onto ski-fields which results in damage due to UV overexposure to parts of the body that are most exposed "non protected by clothing" such as the nose, mouth, chin, cheeks and eyes.

Our work was to assess personal UV exposure of two kinds of skiers (ski instructors and skiers) at the Alpine ski field of La Thuile-Les Suches (45.7°N, 6.6°E, 2100m a.s.l.) in Valle d'Aosta region (Italy).



Where is Valle d'Aosta region?



The field campaigns

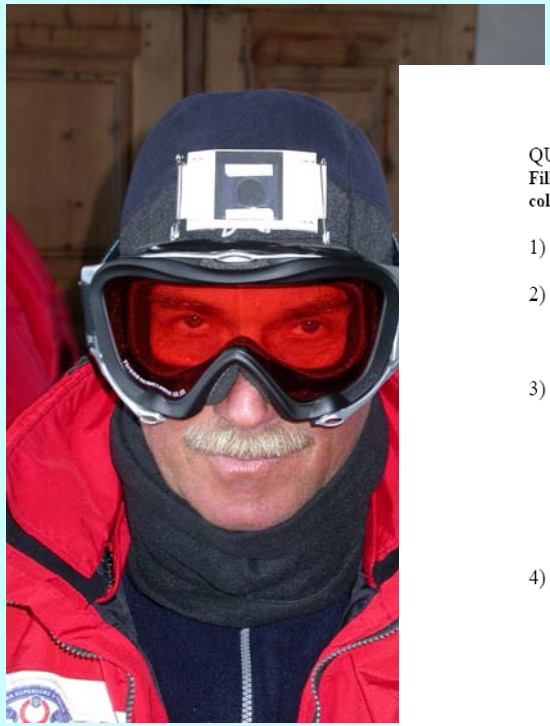
March 31-April 2,3 4 2006 (h:10am-4pm LT),

UV Index = 6

January 29-30, 2007 (h:10am-4pm LT)

UV Index = 2

A vertically oriented polysulphone dosimeter, was attached to the cap to be changed every two hours in order to avoid saturation.



A questionnaire to be filled in at every PS change.

QUESTIONNAIRE

Fill in please the following questionnaire, that will help us to interpret the results collected with your collaboration. Thank you!

1) Date: Name:

2) Fill in with the sequence of dosimeters you wear:

3) Fill in with a cross to describe your activity between one dosimeter change and the following:

Time	At Sun	Partially at Sun	In the shadow	Standing	Skiing	On the skilift

4) Fill in with the time and duration of breaks in closed rooms:

We carried out measurements of:

-skin colorimetric parameters (L*, a*, b*) using a Minolta spectrophotometer;

-skin temperature using a portable non contact-infrared thermometer.

Both before and after the exposure on an exposed site (cheek) and on a non exposed site (forearm).

Polysulphone dosimetry

1) measuring ambient UV erythemal dose

2) calibration curve : dose vs change in PS film absorbance before and after the exposure at 330 nm (ΔA)

$$D=c[(\Delta A)+(\Delta A)^2+9(\Delta A)^3]$$ (Diffey, 1989)

uncertainty: 10%

3) personal dose, Exposure Ratio (ER = ratio between personal dose and ambient dose)

1) measuring ambient UV dose

YES UVB-1 at Saint Christophe-Aosta (45.8°N, 7.4°E, 569m);

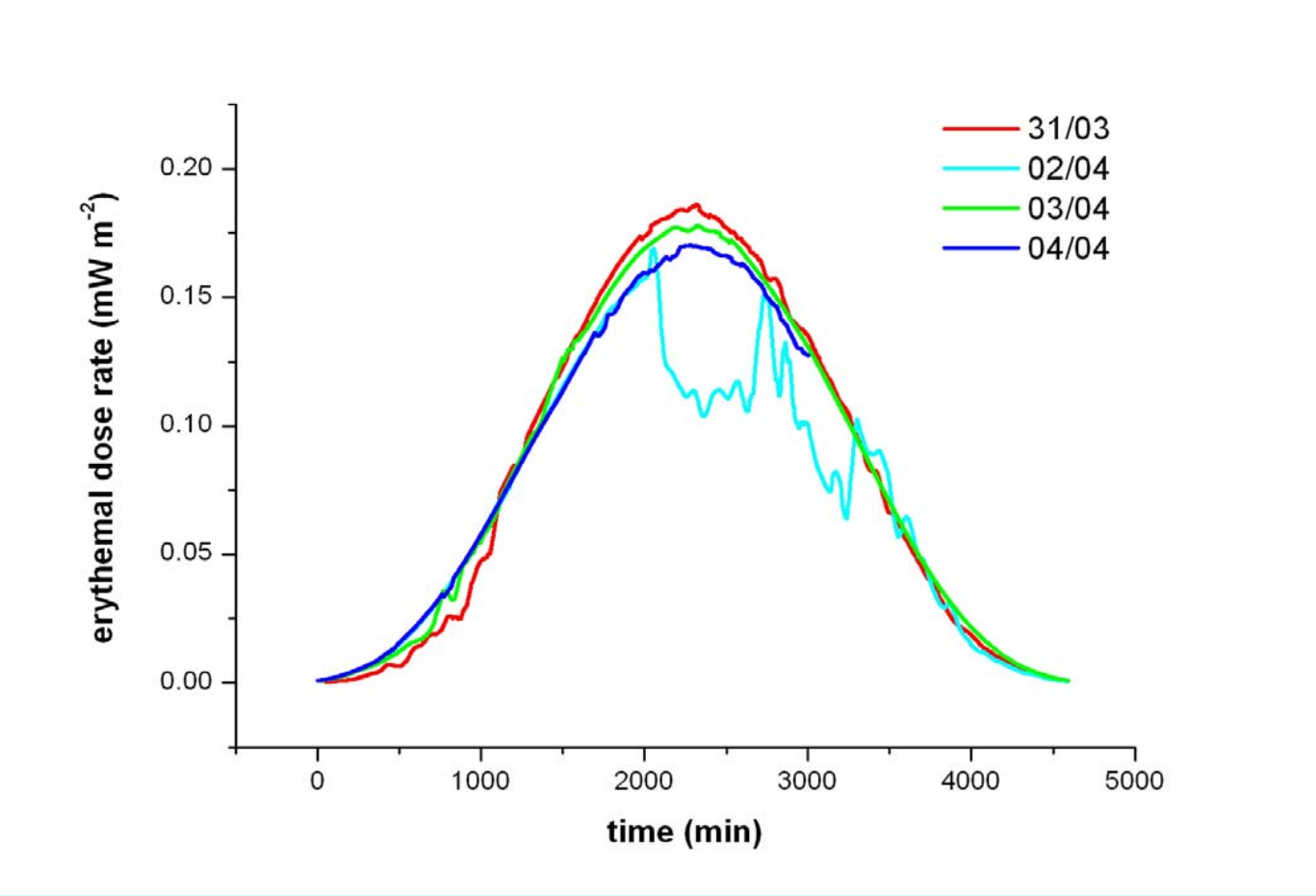
UV-S-AE-T a Kipp & Zonen at La Thuile-Les Granges (45.7°N, 6.6°E, 1640m);

UV-S AE-T Kipp & Zonen at La Thuile-Les Suches (45.7°N, 6.6°E, 2100m)

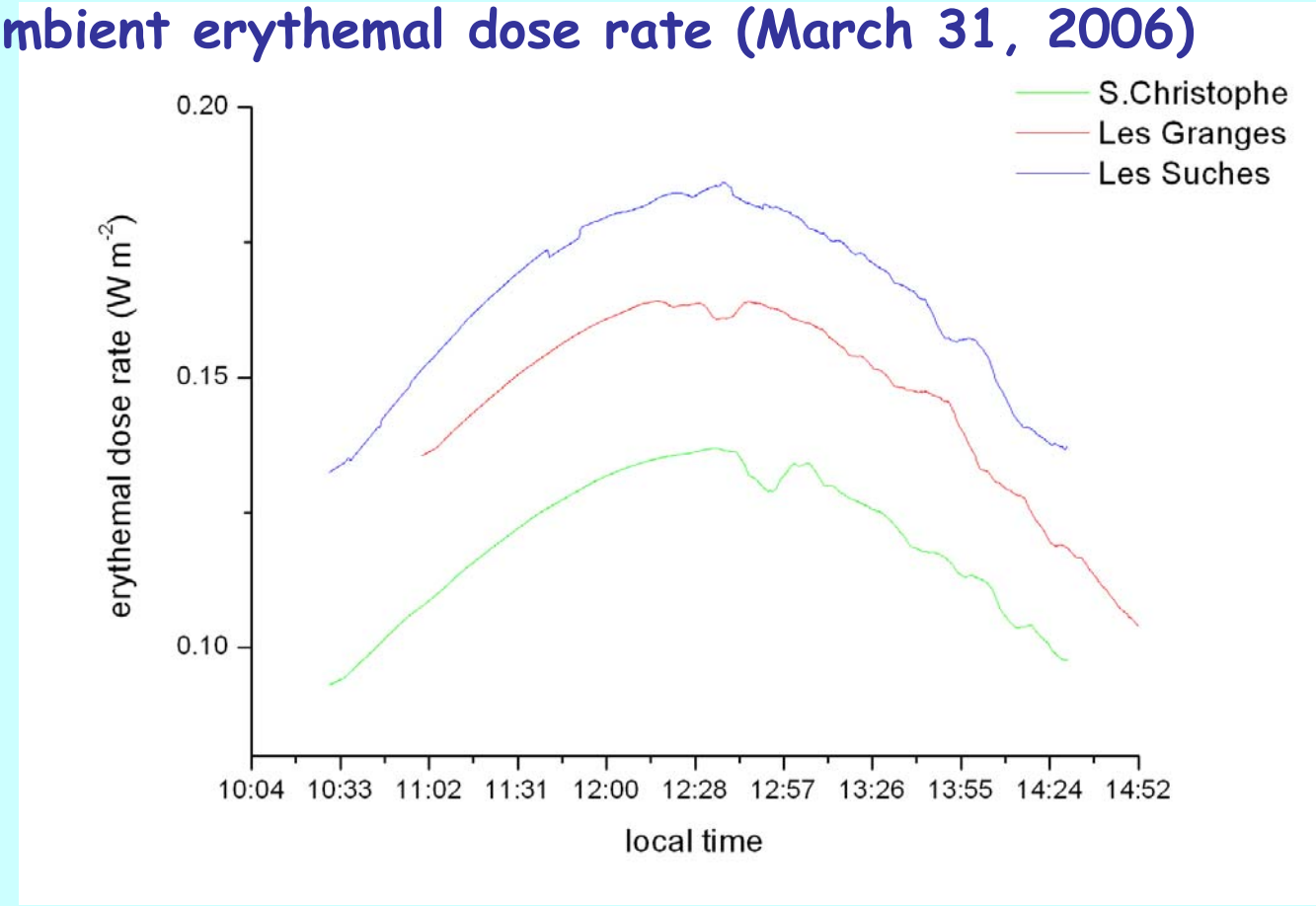
+

The UV broad-band radiometers belong to ARPA VdA

Ambient erythemal dose rate at La Thuile-Les Suches



Ambient erythemal dose rate (March 31, 2006)

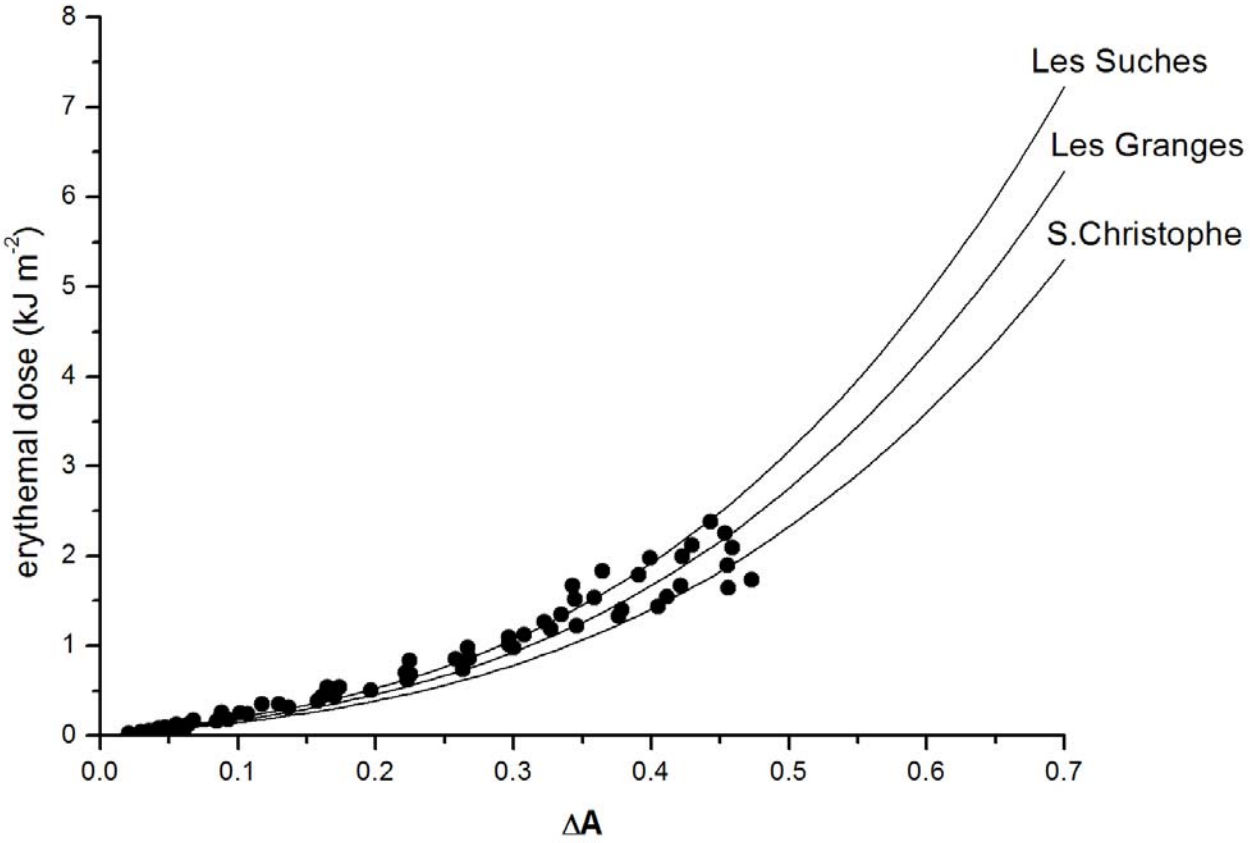


Les Suches-Saint Christophe: 37.7% /1531m (24%/1000m)

Les Granges–Saint Christophe: 22.1%/ 1071m (20%/1000m)

Calibration curves

31-March, 2007



$C = (1.69 \pm 0.02)\ kJm^{-2}$

$C = (1.47 \pm 0.01)\ kJm^{-2}$

$C = (1.24 \pm 0.01)\ kJm^{-2}$

Casale, Borra, Colosimo,Militello, Siani, Sisto "Variability among polysulphone calibration curves", Phys. Med. Biol. 51, 4413-4427, 2006.

Percentage difference:44%, 35%, 25%

Demographic characteristics of the skiers. Count indicates the number of individuals participating in the campaigns.

			Skier type		Total
			Instructor	Skier	
	Spring	Count (Male, Female)	25 (22, 3)	24 (17, 7)	49 (39, 10)
		% within Season	51.0%	49.0%	100.0%
		Age Median (min-max)	49 (21-66)	40 (25-62)	41 (21-66)
	Winter	Count (Male, Female)	12 (11, 1)	20 (15, 5)	32 (26, 6)
		% within Season	37.5%	62.5%	100.0%
		Age Median (min-max)	42 (20-59)	38 (25-62)	40 (20, 62)

Total Number of days participation (Spring+Winter) by season by skier type

.

Skier type	Total No of days participation		Season			
			Spring	Winter	Spring + Winter	Total
Instructor	Total Days on slopes	1	14	12	0	26
		2	6	0	6	12[c]
		3	5[a]	0	0	5
	Total		25	12	6	43
Skier	Total Days on slopes	1	11	20	0	31
		2	13	0	4	17
		3	0	0	9[b]	9
	Total		24	20	13	57

[a] five instructors in spring participated on 3 study days

[b] nine skiers participated in both seasons for a total of 3 study days (2 in spring and 1 in winter)

[c] Over the whole study period -twelve instructors and seventeen skiers participated each on 2 study days,

SPRING		
	Skiers n=24 Median (min-max)	**Ski-instructors n=25 Median (min-max)**
Exposure time (min)	120 (60-150)	120 (80-180)
Personal dose (J/m^2)	599.3 (241.2-1654.8)	645.0 (196.8- 1599.7)
Ambient dose (J/m^2)	746.1 (212.0-1461.5)	928.5 (146.9-1651.1)
ER $_{10am-12am}$	0.96 (0.32-1.33)	0.81(0.46-1.72)
Exposure time (min)	120 (60-180)	120 (60- 140)
Personal dose (J/m^2)	1002.0 (227.2-1917.3)	855.4 (518.9-1530.5)
Ambient dose (J/m^2)	998.7 (212.0-1456.6)	964.2 (644.3-1230.5)
ER $_{12am-2pm}$	1.04 (0.75-1.75)	1.00 (0.51- 1.30)[a]
Exposure time (min)	120 (50-170)	90 (60-140)
Personal dose (J/m^2)	896.7 (220.1-2017.2)	713.1 (506.6- 919.5)
Ambient dose (J/m^2)	904.2 (186.0-1461.5)	648.6 (505.7- 791.5)
ER$_{2pm-4pm}$	1.21 (0.65-1.52)	1.08 (1.00- 1.16)[b]
Daily ER spring	1.05 (0.63-1.37)	0.93 (0.46 -1.72)

[a] ten instructors used the second dosimeter; [b] only two instructors wore the third dosimeter.

WINTER		
	Skiers n=20 Median (min-max)	**Ski-instructors n= 12 Median (min-max)**
Exposure time (min)	120 (110-185)	140 (100- 170)
Personal dose (J/m^2)	170.6 (117.4- 272.9)	320.8 (496.6- 107.2)
Ambient dose (J/m^2)	293.9 (263.9- 421.5)	341.0 (224.9- 385.2)
ER $_{10am-12am}$	0.59 (0.40- 0.85)	0.96 (0.29- 1.46)
Exposure time (min)	120 (65-145)	
Personal dose (J/m^2)	119.5 (76.7-167.7)	
Ambient dose (J/m^2)	301.8 (255.4-354.6)	
ER $_{12am-2pm}$	0.41 (0.25-0.55)*	
Exposure time (min)	120 (85-135)	
Personal dose (J/m^2)	70.1 (18.8-135.5)	
Ambient dose (J/m^2)	108.8 (65.7-136.8)	
ER$_{2pm-4pm}$	0.69 (0.19-1.02)	
Daily ER winter	0.54 (0.42 -0.70)	0.96 (0.29 -1.46)

*The median of $ER_{12am-2pm}$ is statistically different from the other two values (to be further investigated); $ER_{10am-12pm}$ is statistically different bewteen the two groups.

Participation in both seasons

Skier Type		Age	ER Spring	ER Spring 10-12 am	ER Spring 12-2pm	ER Spring 2pm-4pm	ER Winter
Instructor n=6	Median	45	0.60	0.60			0.88
	Minimum	21	0.46	0.46			0.29
	Maximum	59	1.22	1.22			1.46
Skier n=13	Median	36	1.07	1.00	0.95	1.21	0.51
	Minimum	25	0.81	0.80	0.75	0.65	0.42
	Maximum	62	1.32	1.21	1.75	1.47	0.70
Total n=19	Median	41	1.00	0.93			0.54
	Minimum	21	0.46	0.46			0.29
	Maximum	62	1.32	1.22			1.46

Conclusions

- PS dosimetry was tested in a mountainous environment with professional outdoor workers (ski instructors) and skiers.

  - New data in terms of Exposure Ratio (ER) for the Italian population were provided.

- The average personal UV exposure resulted in being the same, and in some cases even more, than the ambient UV dose. This exceeds the values reported by Gies in the WHO report (2006): UV exposure can vary from 5% to 15% of total ambient UV radiation and for outdoor workers exposures can reach 20-30%.

- In Spring, although afternoon ER is higher than others in both groups, there are no significant differences within and between the groups in their median scores.
- In Winter, the median of $ER_{12am-2pm}$ is statistically different from the other two values (to be still further investigated!); $ER_{10am-12am}$ is statistically different between the two groups.

- Further analysis will be carried out to find a possible relationship between personal UV doses and changes in biological indicators. Colorimetric measurements were taken into account to evaluate UV-induced erythema and pigmentation changes, skin temperatures were measured to determine if individuals experienced significant skin temperature changes.

- Continuous long-term measurements are still needed to assess cumulative outdoor UV exposure.

Acknowledgements

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