Characterization Of Human Behavior In Records Of Personal Solar Ultraviolet Exposure Records

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Introduction

Exposure to solar ultraviolet radiation (UVR) has health benefits such as vitamin D production but excess exposure can lead to sunburn, cataracts and skin cancer. Risk factors associated with sun exposure can be limited by using sun protection measures. Personal sun exposure differs from ambient UVR as it is influenced by behavior, movement and bodily location; which are an indication of individual exposure behavior.

The analysis of personal exposure records with wavelet-based spectral analysis (WTS) has shown that personal exposure is characterised by long-range temporal behavior, that changed from uncorrelated to long-range correlated with increasing duration of time spent in the sun. Individual exposure patterns can be classified using WTS.

In this study we aim to show that even if the total exposure is an influencing factor, the repeated or continuous exposure to UVR will influence the WTS slope. Here we present a selection of results to best illustrate our findings.

Data and methods

Electronic dosimeters were used to measure UVR exposure at a high sampling rate of participants in different locations, while they were engaged in various activities. The daily total exposure was recorded in each location using a dosimeter placed on a horizontal surface. The locations and activities are described in Table 1. This included an inside/outside (I/O) simulation to see how regular behaviour would reflect in statistical functions.

Table 1. Description of experimenters conducted using electronic dosimeters

Location	Altitude	Activity
Pretoria, South Africa (-25.77°,28.21°)	1433	Inside/outside simulation
Potchefstroom, South Africa (-26.68°,27.08°)	1368	Car guard
Val Cenis, France (45.21°, 6.53°)	2143	Skiing
Stara Planina, Serbia (43.24°,22.33°)	921	Skiing
Dolomites Mountains, Italy (46.43°,11.55°)	1999	Hiking
Avondale, New Zealand (-36.89°, 174.69°)	12	Golf

The scaling exponent (α) of the personal exposure time series were characterised using the 2nd order detrended fluctuation analysis (DFA2) and are appropriate to deal with nonstationary records. The WTS power-law exponent (β) provides scaling information and the contribution to signal energy. The calculated DFA2 and WTS functions were used estimate the α and β of linear fits.

Results and discussion

The results for the I/O simulation (Fig. 1), showed that the superposition rule of the DFA2 and WTS functions are dominated by the outside behavior in the lower time scales and that ambient UVR is dominant in the upper time scales. The DFA2 and WTS results showed that the repeated patterns could be correctly extracted using the superposition rule.

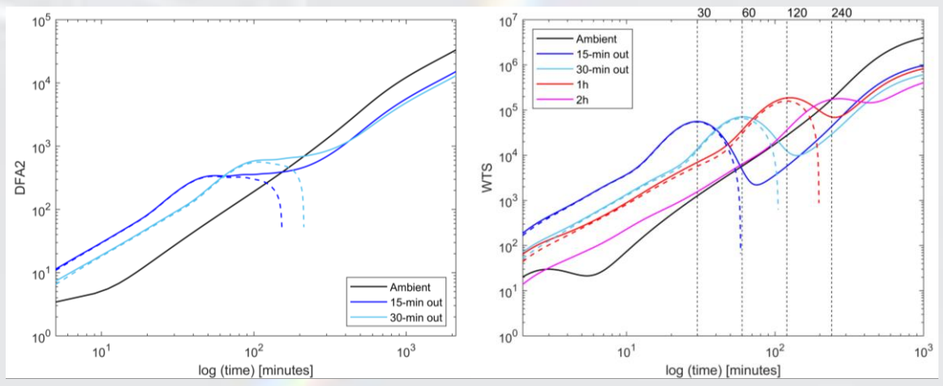

Figure 1. DFA2 (left) and WTS (right) results from inside/outside simulation, with the dashed lines representing the superposition of the respective result.

The DFA2 and WTS results from skiers (Fig.2) represent one of long, continuous exposure and another with random, short exposure times. The WTS graphs can help determine the longest exposure duration and suggest that the DFA2 and WTS, at lower scales, are mainly driven by continuous exposure times.

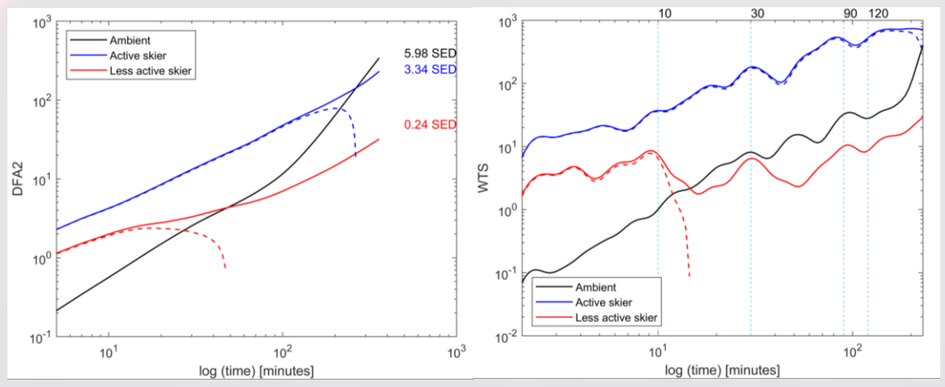

Figure 2. DFA2 (left) and WTS (right) results from skiers with the dashed lines representing the superposition of the respective result.

The superposition rule can identify different behavioral patterns and can be repeated with WTS analysis as well. The analysis of the other experiments confirmed the findings of the I/O experiment. There exists a difference between slopes for the same total exposure but different maximum continuous exposure times. Longer exposures increases α and β values. DFA and WTS can be used to describe and quantify personal behavior. Finally, we found that higher frequency data improves the shape of the WTS function from the superposition rule

Conclusion

The use of DFA and WTS are valuable in the analysis of big data in order to understand the public health impact of sun exposure. A complete discussion of results were published in "*Characterization of personal solar ultraviolet radiation exposure using detrended fluctuation analysis*".