UV Index Variations (1960-2006) and Melanoma Skin Cancer Incidence in Australia

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Abstract. Surface ultraviolet (UV) radiation can have an important impact on human health and terrestrial ecosystems. In humans, increased exposure to UV radiation increases the risk of skin cancer. In Australia, public communication campaigns for skin cancer prevention include the promotion of daily UV forecasts. However, it is estimated that nearly 450,000 Australians still get skin cancer every year, including more than 10,000 cases of melanoma, the most dangerous form of skin cancer. Hence, it is important to monitor Australia's UV radiation levels over time, in particular, because of the effects cumulative exposure can have on humans. The amount of surface UV radiation strongly depends on stratospheric total ozone amounts, geographical location, date, and time of day. Ozone absorbs part of the UV radiation over the wavelength 300-400nm, which is the UV radiation that is most important for humans and ecosystems. Reductions of stratospheric ozone result in surface UV radiation increases. Variations in surface radiation related to ozone depletion have been reported for several locations worldwide during the last few years. In this paper we present and discuss the variations in the UV Index and melanoma skin cancer incidence for Australia over the period 1968-2008.

UV Index Variations (1960-2006)

We used gridded monthly average total ozone measured by NASA's Total Ozone Monitoring Spectrometer (TOMS), Ozone Monitoring Instrument (OMI), ECMWF's ERA40 reanalysis monthly total ozone and meteorological fields from the Bureau of Meteorology climate model, as input to the UV radiation code, to calculate local-noon clear-sky UV Index (Lemus-Deschamps et al., 2004, 2006). UV Index levels below 3 are considered low, 3 to 5 moderate, 6 to 7 high, 8 to 10 very high and above 11 extreme. The associated color code used and suggested sun protection is illustrated in Figure 1.

Figure 1. UV Index levels categories and sun protection tips.

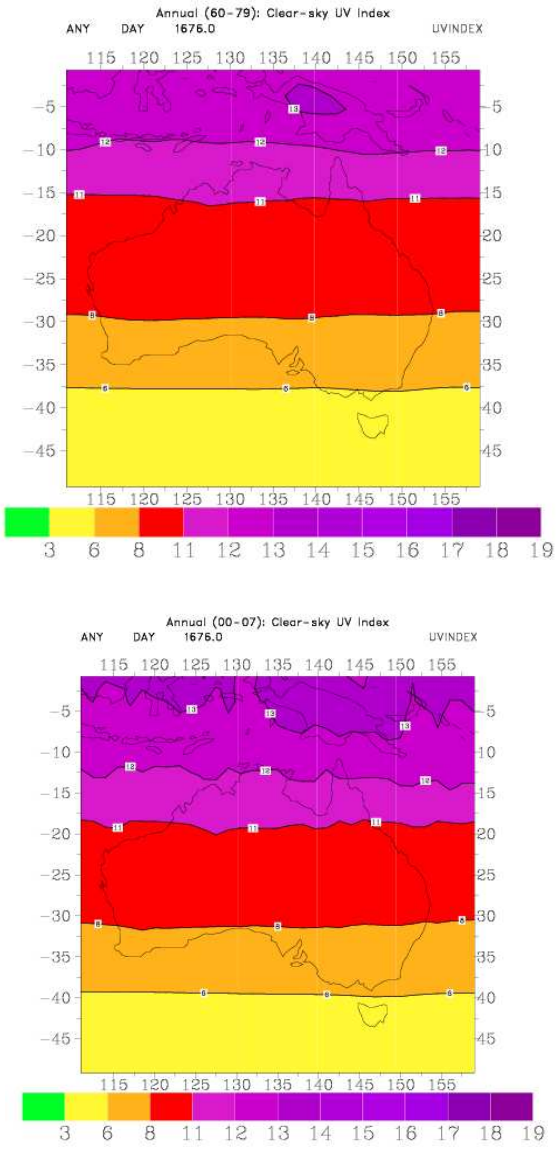

Figure 2. Annual clear-sky UV Index average over 1960-79 and 2000-2007.

The annual average over (1960-1979) and (200-2007) presented in Figure 2 shows that, for the twenty century, the UV Index level "11" is displaced about 5degrees from 15 degrees to twenty degrees south . UV level 8 (28˚S, top panel Figure 2) and level 6 (37.5˚S, top panel Figure 2) also are displaced about 5 degrees south (bottom panel Figure 2). The day-and-time of the year, latitude, longitude, altitude, uv-surface-albedo, ozone absorption dependence on temperature, Rayleigh scattering, solar irradiance, aerosols are taken into account to calculate

clear-sky local-noon UV Index. Monthly averages for each month over the period (1960-1970) were calculated and subtracted from the monthly UV Index. The long-term spatial and temporal deviations from 1960-1970 were calculated for North (10-29S), Central (29-37S) South (37-45S) Australia (Figure 2).

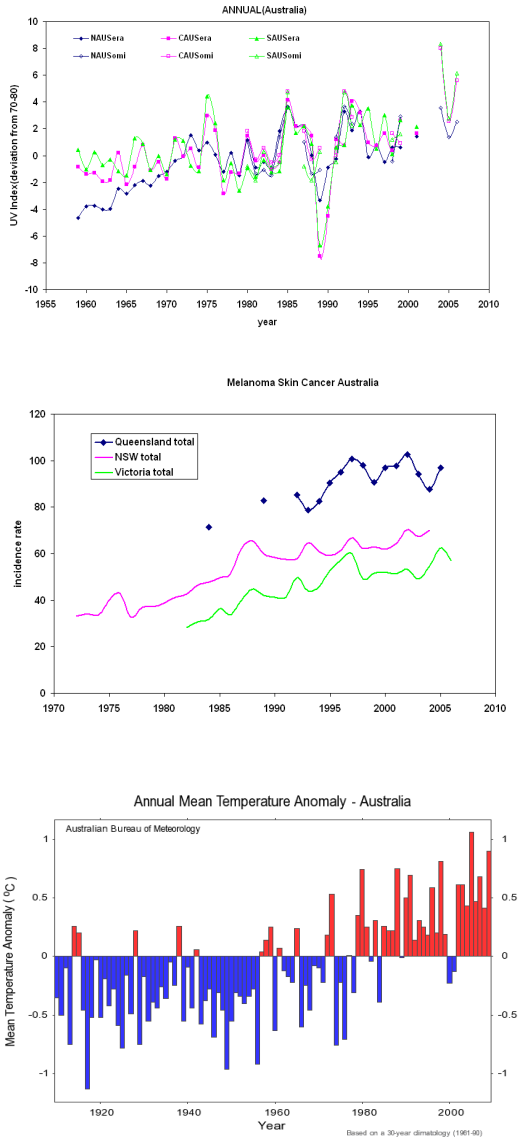

Figure 2. Annual monthly clear-sky UV Index (%) deviation from 1960-1970, calculated for North (10-29S), Central (29-37S) and South (37-46S) of Australia, Non Melanoma Skin Cancer Incidence for Queensland (137-157E,12-25S) New South Wales (140-167E,12-35S) and Victory (140-167E,32-40S), and Australia's annual mean temperature anomaly (NCC, Bureau of Meteorology).

An ongoing increase of clear-sky UV Index level is observed for all regions since the seventies. It is well know that Australians love the outdoor life style. Hence, it is more likely that they will be out-door and be subject to UV-sun-exposure when temperatures are warm and there are clear-skies. Figure 2 shows that temperature has been on the rise since 1990. This combined with, people's outdoor living style, and the UV increases could result on increased exposure to high UV levels, potentially resulting in Melanoma Skin Cancer incidence increases. For North and Central Australia, during winter UV Index levels are still high (not shown here), however people could have the perception that UV levels are low because it is winter. This, combined with warmer temperatures, but more pleasant temperatures than in summer, when it is more likely that people will carry out outdoor activities, could result in increased exposure to high UV radiation levels. For Southern Australia UV increases are observed mostly during summer (not shown here), when high temperatures are likely, and people is more likely to be outdoors.

Summary

For Australia, the results suggest that there is a connection between increases on UV levels, exposure to uv-radiation during hot weather, and melanoma incidence. An ongoing increase in Melanoma skin Cancer (Figure 3) is observed, being more pronounced to the North. The results show that UV Index levels have been on the rise since the seventies. Having said that, we can not exclude that people, that love outdoor activities, are most likely exposed to high levels of uv-radiation when hot weather-clear-skies prevail. Winter UV levels to the North-Central Australia are of particular interest, since the UV levels are high all year around. Hence, the perception that UV levels are low during winter, may be misleading.

References

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