The future of the ARPANSA UV monitoring network

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Abstract. ARPANSA has operated a solar UVR monitoring network since the mid-1980s. UV Index data collected by the network is published in near real time on the internet and is used to inform and educate the public about the dangers of UV over-exposure. The current network consists of broadband UV detectors at 11 sites in Australia and a further four detectors at Australian Antarctic Division bases. A scanning spectroradiometer located in Melbourne provides the reference calibration for the field detectors. This paper presents details of the proposed refresh of the network which will occur in several stages beginning with the logging and communications modules, then the data analysis and archiving processes and finally the UV detectors. The intention is to maintain the existing core network of detectors and develop the capacity to expand the network using low-cost alternative UV detectors.

Introduction

Australia is a high solar UVR environment due to the combination of relatively clean atmosphere and Earth's orbit being closer to the Sun during the southern hemisphere summer. In addition Australia has a predominantly fair skinned population and a climate conducive to an outdoor lifestyle resulting in great potential for solar UVR overexposure. It is estimated that two in three Australians will be diagnosed with skin cancer by the time they are 70 (Cancer Council Australia, 2014).

The ARPANSA broadband solar UV network currently operates in 11 locations around Australia (Adelaide, Alice Springs, Brisbane, Canberra, Darwin, Kingston near Hobart, Melbourne, Newcastle, Perth, Sydney and Townsville). The existing arrangement provides "coverage" for 15 million people, around two thirds of the Australian population. Data from the network is updated once a minute on the ARPANSA website.

As well as providing data to researchers, the purpose of the solar UVR monitoring network is to raise the general public's awareness of UV issues. By providing the information to enable better decision making relating to sun exposure ARPANSA hopes to drive changes in behaviour that will ultimately contribute to easing the burden of skin cancer on the Australian health system and population.

A new approach

The advent of smart phones has heightened the expectations of the public who now demand localised information about their potential UV exposure. Sophisticated modelling performed by the Bureau of Meteorology is used to forecast the solar UV for all areas of Australia, but there is little measurement data to support these predictions for locations outside the major metropolitan centres. A single monitoring site can adequately characterise the typical solar UV environment for a large region on the timescale of a day or more. However, this arrangement will sometimes provide a poor indication of the immediate UV exposure for people within one of Australia's sprawling cities but far from the detector location.

The existing network employs broadband UVB detectors (UV Biometer model 501, Solar Light Company, Philadelphia PA, USA) and is based on legacy hardware that is now becoming increasingly difficult to maintain. Each remote site currently requires a dedicated PC104 computer running Windows XP and a modem/router with fixed IP address. In addition it must be supplied with an ADSL landline and mains power. Data is transferred via FTP requests originating from ARPANSA. The data is stored as text files which are manipulated by a series of scripts to generate the output for web pages.

While this system has worked well in the past it is not particularly flexible and will be difficult to adapt to the anticipated changing demands in the future. A new approach is required, adopting more advanced technology to standardise, modularise and automate the operation of the network. The plan is to replace the existing remote computers with new data logging and communication devices, automate more of the data analysis, presentation and archiving processes and introduce low cost photodiode based UV detectors. Implementation of these three stages will make it possible to consider deploying multiple detectors across major urban centres, short term deployments to sites of particular interest (e.g. holiday destinations, outdoor events, remote work sites, sites of personal exposure studies) and partnership arrangements with organisations such as local government councils, schools and childcare centres, surf lifesaving clubs to host UV detectors.

Data loggers

ARPANSA has developed a data logger and communications device (DLC) to read, store and transmit the output of various UV sensors (see Figure 1). The DLC comprises three modules:

- main data acquisition control board including a microcontroller unit, eight analogue to digital input channels and a micro SD card for data storage,
- GPRS modem board for communication over the GSM mobile phone network, and
- interface board for controlling the UV Biometer detectors currently used in the network.

Being a microcontroller, the DLC requires no operating system and avoids the associated complications of antivirus and firewalls. The GPRS modem board is fitted with a machine-to-machine SIM card that enables the DLC to push data through the mobile phone network using predefined authentication to a dedicated receiving server. When only hosting lower power photodiode detectors the DLC may be powered by a 10 W solar cell charging a 32 Ah lead acid battery. The higher power demands of the

Peltier device used to control the temperature of the UV Biometer requires mains power.

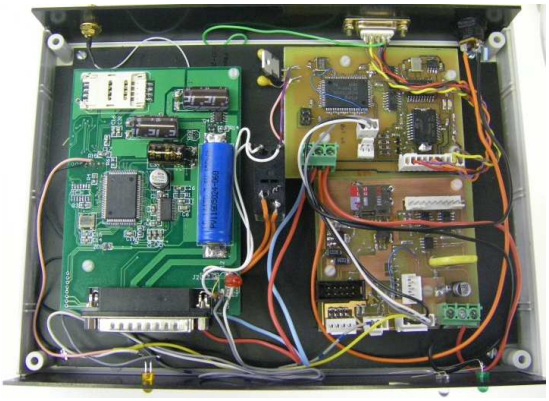

Figure 1. ARPANSA's data logger communications device (DLC). The three modules are (clockwise from left) GRPS modem, UV Biometer interface and main board microcontroller unit.

Data transmission

Once per minute the DLC sends a single line of data to a dedicated server. This data file contains:

- a date and time stamp (obtained from the mobile phone network)
- an identifying code (the 14 digit IMEI of the SIM card)
- raw data from the Biometer including UV level and unit temperature
- data from any devices connected to the analogue input channels.

This data is also recorded on the micro SD card.

At ARPANSA a listening application inspects the contents of the files as they arrive and transfers the data through the firewall to an SQL database. Calibration information for each of the detectors is also stored in the database. SQL queries will be used to retrieve the data and create the dynamic web pages.

UV detectors

The UV Biometers are Robertson-Berger style detectors that measure erythemally weighted UVB. These detectors filter the UV component of sunlight which then excites a temperature stabilised phosphor and the visible light emitted is monitored by a GaAs photodiode. UV Biometers have a long history of performance in many networks around the world and it is expected that they will continue to form the basis of ARPANSA's UV monitoring network for the next five years.

In recent years many comparatively cheap detectors have become available which use photodiodes that respond directly to UV, require little power to run and are simple to interface. Presently ARPANSA is trialling a UV sensor probe (model GUVB-S11SC-3LWH3, Genicom Co Ltd, Daejeon, Korea), and is also constructing a prototype detector employing a two channel SiC photodiode (model JEC 1I-DE, IFW Optronics GmbH, Jena, Germany). As shown in Figure 2, both of these detectors have a spectral response approximating the erythemal response of human skin (CIE, 1987). For comparison, the mean response and range of ARPANSA's current stock of UV Biometers is also shown.

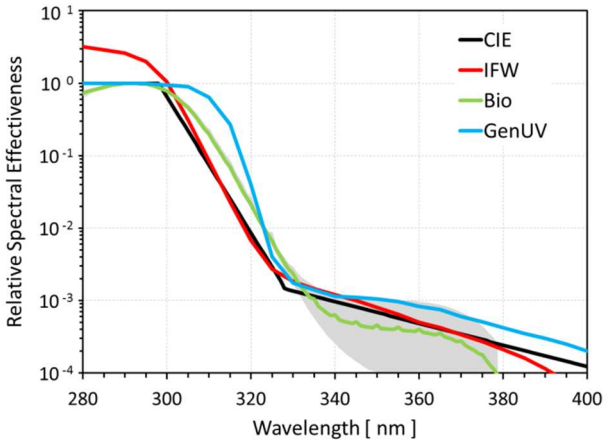

Figure 2. Relative spectral response of broadband UV detectors (IFW photodiode —, Solar Light Biometer —, Genicom UV sensor —) compared with the CIE erythemal action spectrum — (CIE, 1987).

Prior to deployment at other sites the UV Biometers are calibrated at ARPANSA's laboratory in Yallambie by comparison with a UV spectrometer (model DTMc300, Bentham Instruments Limited, Reading, UK). The UV spectrometer is calibrated for irradiance using a 1 kW Tungsten filament lamp traceable through Australia's National Measurement Institute and the wavelength calibration is based on the UV spectral lines of a mercury lamp. Performance of the new photodiode detectors will be judged in comparison with the data from both the UV spectrometer and the UV Biometer detectors.

Summary

At present two DLC units have been constructed and are being tested, with the first production run expected later in 2014. The next steps are to create the SQL database for handling the incoming data and to continue evaluation of the UV photodiode detectors. The DLC provides an exciting opportunity for transformation of the ARPANSA solar UV monitoring network into a nimble, scalable and adaptable system of detectors ready to meet the increasing demands of its stakeholders.

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