Story behind the two UVI Apps: uv2Day and GlobalUV

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Abstract. We describe two apps independently written for the Android and IOS platforms to provide UVI forecasts and associated behavioural advice. The apps were developed in response to a request for more detailed information on UVI required by patients with a high risk of melanoma. However, the information is more generally applicable. As well as being an educational tool to interpret the UVI, it enables users to plan their day to optimise their UV exposure. Accuracy is assessed by comparisons with high quality measurements.

Introduction

The development environment used for android phones is Android Studio and the language used is Java. For IOS (Apple), the development environment used is XCode and the language used is Swift (a recent language developed by Apple). On both platforms the apps use the SQLite data base for internal storage.

App 1: uv2Day.

This app is designed to be used in New Zealand, Australia and the South Pacific/Antarctica regions, and receives calculated UVI forecasts from NIWA once per day. The app provides UVI values and corresponding behavioural messages concerning skin damage for the nearest town to your location, as determined by GPS, or for other predefined locations at any time of the day. The app is supported by the Cancer Society in New Zealand. Validation of this app is described elsewhere at this workshop (Turner 2018).

App2: GlobalUV.

At start-up, the app downloads daily ozone forecast data provided by NOOA, and noon cloud transmission forecast data provided by the Danish Meteorological Service. In both cases, these are on a 1-degree grid of latitude and longitude. These data are accessed via NIWA servers.

Ozone values, and cloud transmission values are then extracted for the location of interest. The default location for GlobalUV is determined by the phone's GPS reading. However, other locations can be specified. In addition to the tabulated values, the app also holds predefined parameters for approximately 400 specific locations, which sample diverse topographies in most countries of the world. Locations that are not named can be selected by touching a map of the world. In the android version, the user can also define a location for themselves. or, by utilising sliders. The android version also allows estimations of clear sky UVI at other times, using a climatology of ozone.

The app then calculates the solar zenith angle (SZA) at 10-minute steps for the current day and selected location, and then uses a pre-computed lookup table to calculate the variation in clear-sky UVI (as a function of SZA and ozone) throughout the day. It makes use of the following internal fixed tables:

- UVI as a function of sun elevation angle and ozone column amount for the mean Earth-Sun separation.
- Mean ozone amounts for every month of the year for all global locations (actual ozone forecast data are used whenever internet access is available).
- Additionally, it makes use of the tables of the following, as function of latitude and longitude
    - Altitude.
    - Mean aerosol optical depth (at 370 nm)
    - Surface albedo

Once the clear-sky UVI has been calculated, further adjustments are made to correct for variations due to changes in:

Earth-sun distance

UVI = UVI * (1 + 0.035 * cos(2*pi * DoY/365.25)). For example, in early January the UVI is about 3.5% larger.

Altitude

UVI = UVI * (1 + .053 * Altitude in km), because in unpolluted air, UVI increases with altitude by 5.3% per km.

Aerosol extinction

Aerosols are assumed to reduce UVI according to.
UVI = UVI * exp(0.339 * AOD370nm)

Snow Covered Surface

UVI = UVI * (1 + .4 * albedo * exp(-Altitude(km)/7.65)).

(Optionally) Cloud Cover

UVI = UVI * Transmission by cloud.

Further details of the calculation method are available in (McKenzie 2016).

Behavioural Messages

Behavioural messages, that depend on the UVI, are provided in both apps. To emphasise the educational aspects, the uv2Day app assumes Fitzpatrick skin type I (i.e., 2.25 SED per minimum erythemal dose (MED)). However, in the GlobalUV app, different skin types can be selected. For local solar noon and the current time (or for any other time selected), the app reports the number of minutes of exposure before skin damage would be perceptible 24 hours later.

Validation

Several limitations should be mentioned here. Firstly, the cloud forecast grid is rather coarse (~100km), and the forecast for noon is assumed to apply throughout the day. Secondly, the global mean climatology of aerosol extinctions is subject to large uncertainties. Further, no distinction is made between different types of aerosols. Despite these limitations, the app performs well at most sites tested (e.g., see Figure 1).

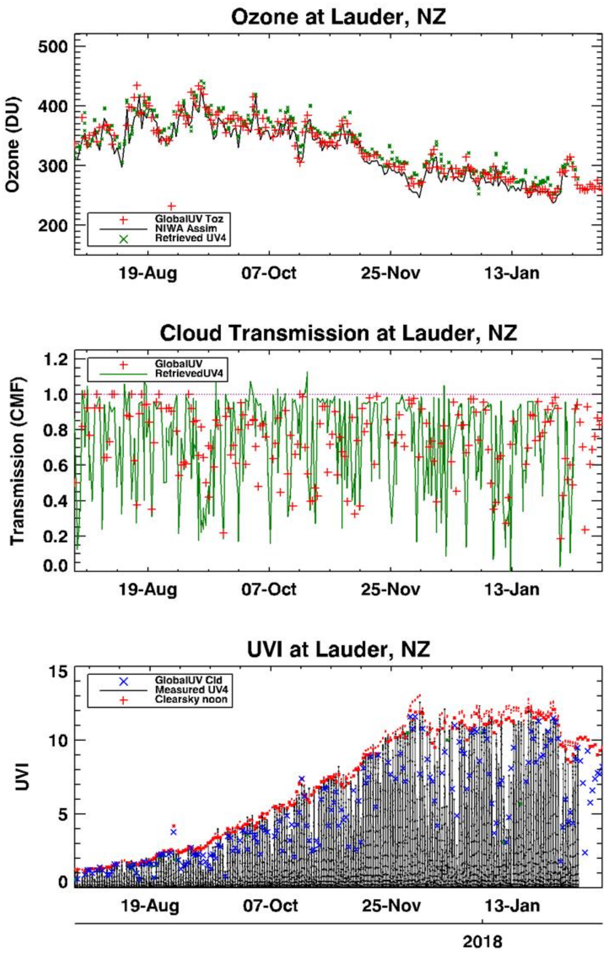

Figure 1. Validation of GlobalUV app for Lauder New Zealand. Comparing time series of ozone (top), cloud transmission (middle), and UVI (bottom) with independent measurements at Lauder New Zealand

In this case (see Fig. 2), the correlation coefficient is 0.87, which means that over 75% of the variance is captured by the app forecasts. There is a tendency to underestimate the highest UVI values, probably because the app cannot reproduce cloud enhancement events.

Performance is similar at other sites for which we have data. However, at Mauna Loa Observatory, the agreement is poorer because local cloud effects differ markedly from the mean over the coarser grid scale. Further work is required to characterise the performance at heavily populated areas.

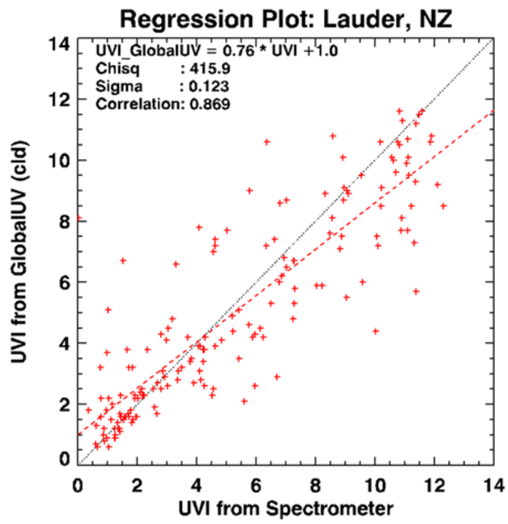

Figure 2. Scatterplot of the UVI data shown in Fig. 1.

Conclusions

UVI is highly variable in space and time, making it difficult to estimate. Yet information on UVI is a requirement for sensible decisions on sun exposure. Too much UV leads to skin cancer, and too little UV increases the risk of vitamin-D deficiency. These apps therefore provide a useful service both from educational and behavioural perspectives. Both apps have been operational for more than a year, with a high success rate. The forecasts from both compare well with measurements, although the effects of clouds are covered better with uv2Day.

Possible improvements to the GlobalUV app include using seasonal, or possibly even daily (once available) forecasts for aerosol optical depth; and improved temporal density of spatial resolution for cloud forecasts. However, these would be at the expense of larger daily downloads. Currently, the downloads consume 3 Mbytes/day.

The uv2Day app already includes high resolution cloud effects throughout the day, rather than just at midday. Currently these are at 1-hour intervals, but will be upgraded to 10-minute intervals. Another possible improvement would be to allow for different skin types. However, while making it more relevant to the user, this could diminish its use as a universally-applicable educational tool.

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References

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