Angular Response Characterisation of Broadband UVB Sensors with Artificial Sources

N. S. Swift[1], K. M. Nield[1], J. D. Hamlin[1], R. McKenzie[2]

1. Measurement Standards Laboratory, Industrial Research Ltd, PO Box 31-310, Lower Hutt, New Zealand
2. National Institute of Water and Atmospheric Research (NIWA), Lauder, New Zealand

Introduction

- Routine annual calibration of UVB sensors used to measure total solar irradiance and hence ultraviolet index (UVI) is necessary to ensure accuracy of long term monitoring networks.
- This includes measurement of spectral and angular response functions.
- A topic not well documented in the literature is the dependence of the angular response on the spectral distribution of the source used to perform the measurement.

Yankee Environmental Systems UVB-1 Pyranometer

- One of the three main stream broadband instruments used to monitor ground level UVB radiation.
- Used in the MSL and NIWA UV networks in New Zealand.

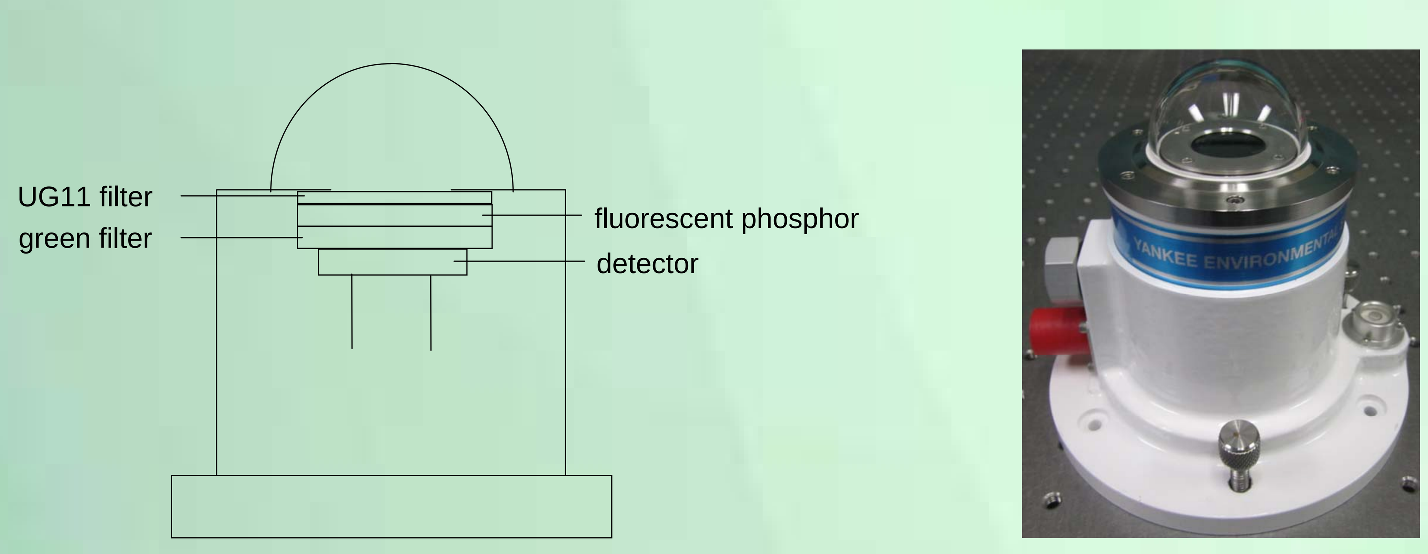

Figure 1. Diagram and photo of a Yankee Environmental Systems UVB-1 pyranometer.

- Spectral response function achieved by UV stimulation of fluorescent phosphor which then emits visible light detected by a green filtered solid state detector.
- The fluorescent phosphor acts as a diffuser.

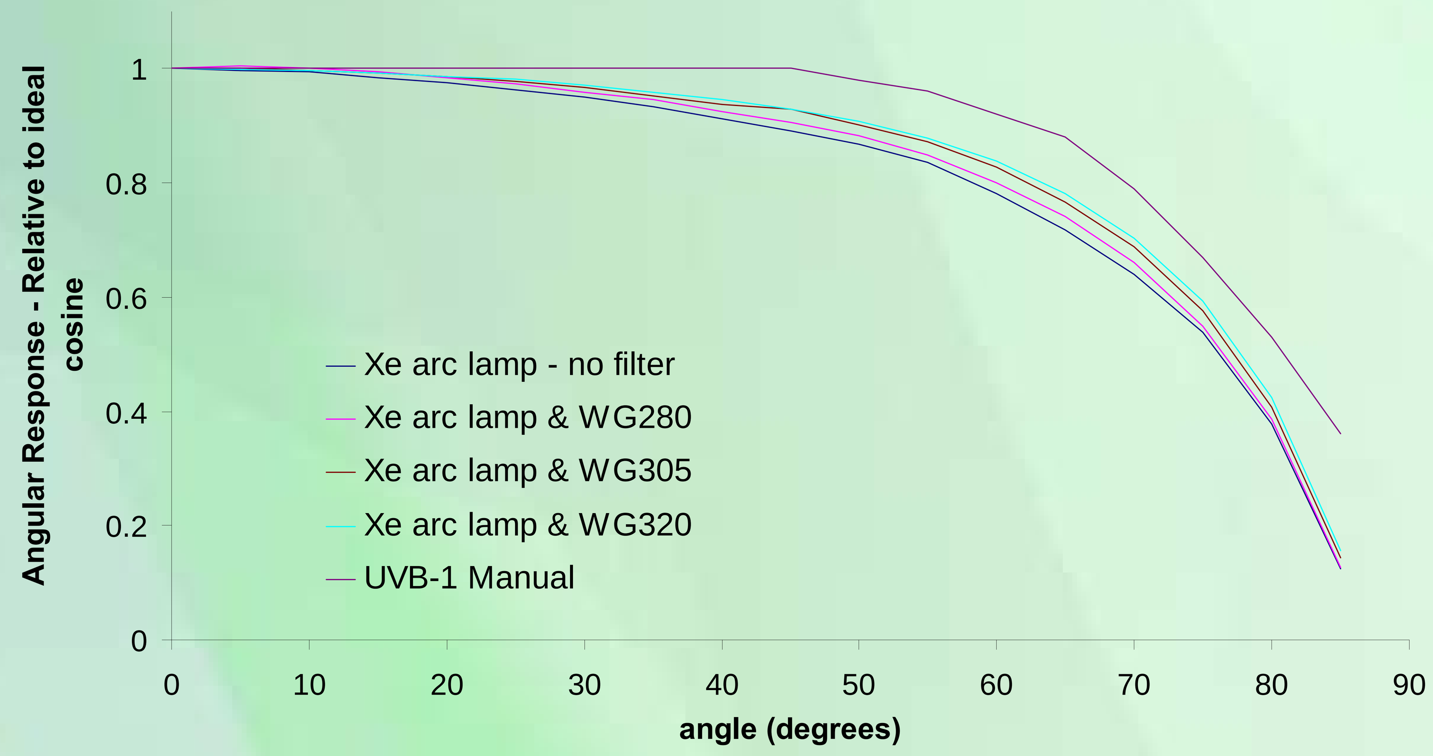

Figure 2. The measured angular response of a YES UVB-1 pyranometer using light sources of varying spectral distributions.

- Figure 2 shows differences in relative angular response between an unfiltered xenon arc source and a WG320 filtered xenon source.
  - 0° to 30° from normal: up to 2 %
  - 35° to 60° from normal: ~ 3 % to 7 %
  - 65° to 90° from normal: ~ 8 % to 21 %
- Results show the larger the short wavelength component of the light source used to perform the angular response measurement, the poorer the match is to the desired ideal cosine response.
- This could be due to angular related variations in penetration depth into the fluorescent phosphor.
- Appropriate source selection achieved by plotting the spectral response function multiplied by spectral irradiance and comparing with the equivalent for typical solar spectra.
- Either tungsten or xenon arc source in combination with the WG320 provides the best approximation.

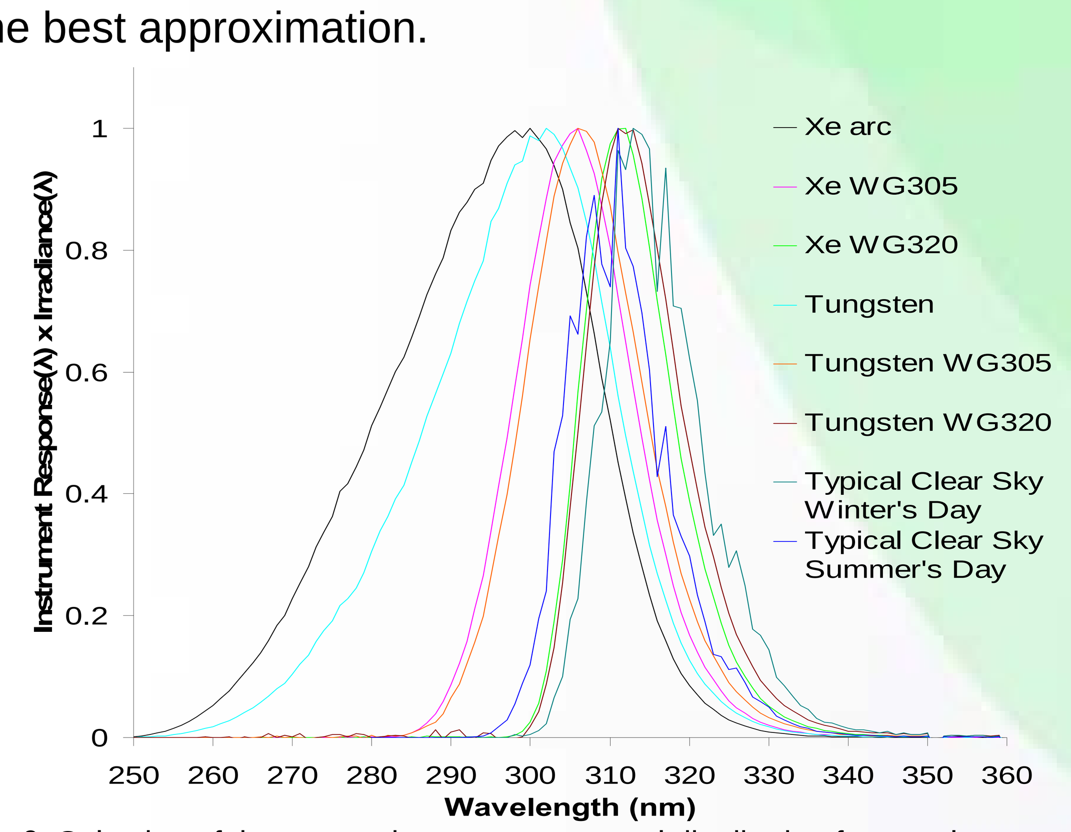

Figure 3. Selection of the appropriate source spectral distribution for angular response characterisation of a Yankee Environmental Systems UVB- Pyranometer.

International Light SED (SEL) 240 Radiometers

- In the process of being retired from the MSL UV network after 23 years of service.
- Spectral response function matches the desired erythemal response function reasonably well but has no temperature control.
- The UG11 was added to decrease the long wavelength responsivity but this did come at the expense of the quality of match to the erythemal action spectrum.

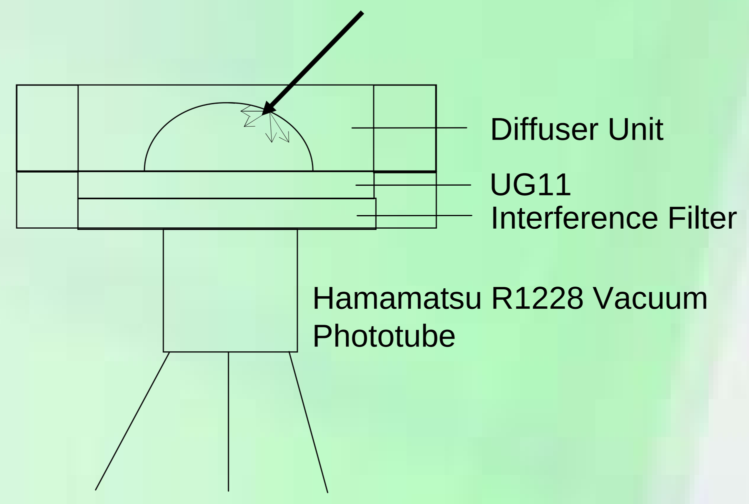

Figure 4. Diagram of an International Light SED (SEL) 240 Radiometer modified with addition of a UG11 filter.

- Achieves spectral response function by interference filter and vacuum phototube.

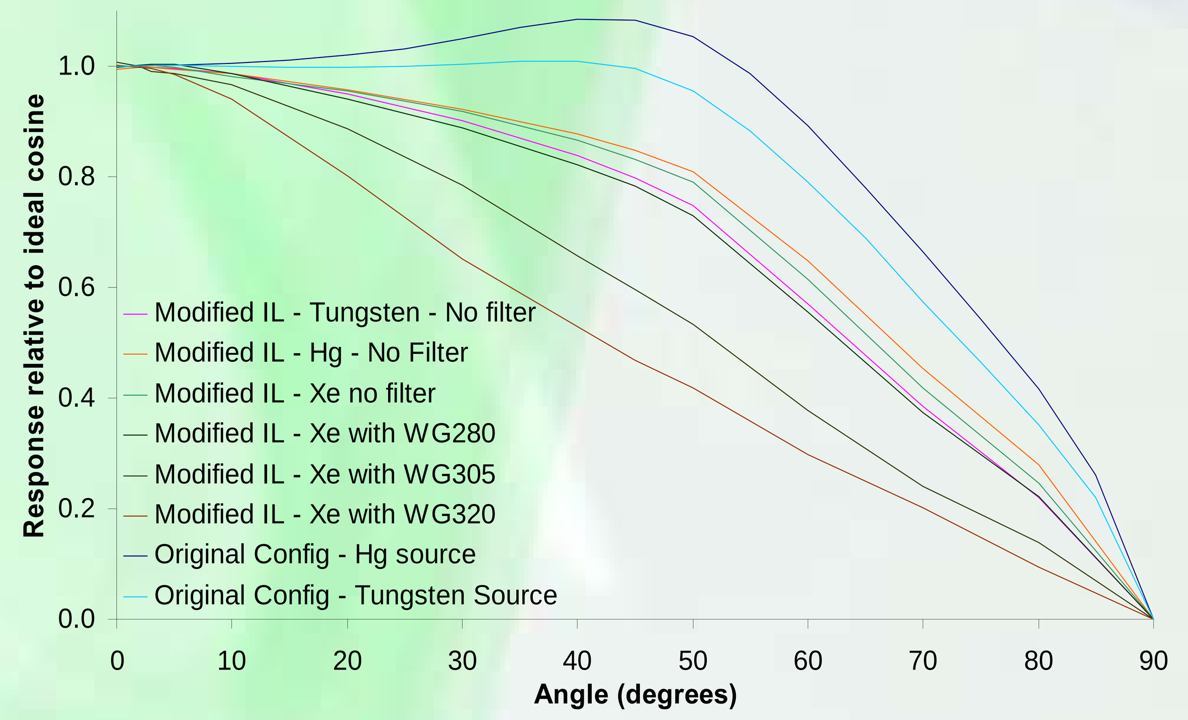

Figure 5. The measured angular response of an International Light radiometer including measurements before and after modifying the instrument with addition of a UG11 filter.

- The angular response improves with larger UV component sources.
- The addition of a UG11 filter has detrimentally altered the quality of angular response for all light sources.
- These changes could be caused by the wavelength related changes in refraction angle causing the incidence angles on the interference filter to vary.

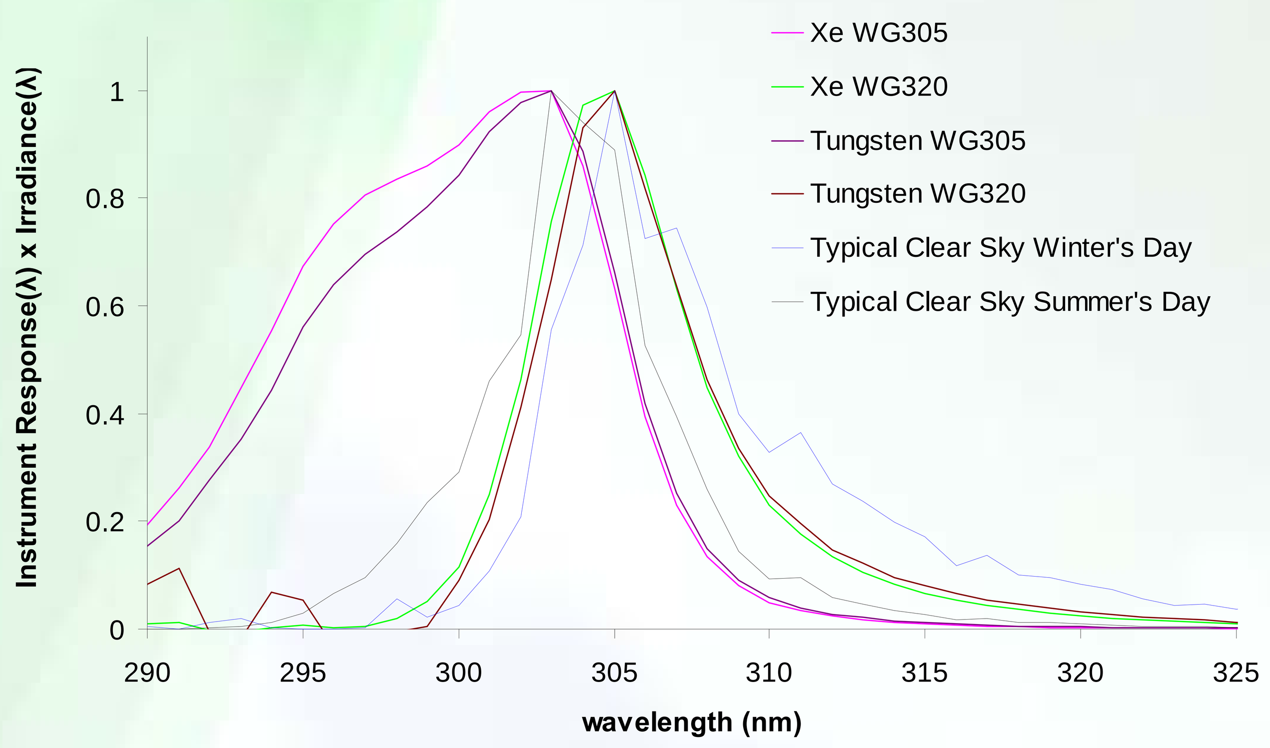

Figure 6. Selection of the appropriate source spectral distribution for angular response characterisation of an International Light radiometer.

Conclusions

- The measurements are performed using a point source only and hence corrections are necessary when used out in the field to account for the diffuse sky component.
- The angular responses of the measured instruments vary significantly from the desired ideal cosine response.
- The angular response of each detector has a significant spectral dependence.
- It is therefore important to characterise the angular response of such types of detector using a laboratory source which best approximates a daylight spectral distribution.

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