UVA, UVB & UVI Sensors

SKU 400 Series

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Skye Instruments Ltd.

Skye Instruments is based in the UK and we are very proud to be celebrating being in business since 1983. Our products are designed and built in the UK. We have a very wide product base and our sensors & systems are used for plant & crop research; micro-climate, global climate change studies; environmental monitoring and controlled environment installations.

Products include light sensors & systems, weather monitoring sensors, automatic weather stations, plant research systems, soil and water research systems.

Feel free to contact us via our e-mail, or any of the methods below. Please click on the icons to browse the sites, or search for the usernames.

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Have a Smartphone? Scan this QR code to access our website for more information about your product:

Please be aware that the information in this manual was correct at time of issue, and should be 100% relevant to the accompanying product. We take great pride in our ever-evolving range of products, which means that sometimes the product may change slightly due to a re-design. If you have any queries, please do not hesitate to contact our technical team by any of the methods above.

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UVA, UVB and UVI Sensors

1. INTRODUCTION

Skye Instruments' family of specialist light sensors include sensors to measure different parts of the ultra violet, visible and infra-red spectrum, for a wide range of applications.

All sensors use high quality photodiodes and spectral filters, and are individually calibrated to National Standards. Each is supplied with its own unique traceable Calibration Certificate. Skye's UV sensors can be used in many applications from the assessment of solar radiation damage on materials (weathering), solar radiation damage to human and animal skin (sunburn) to monitoring the output of UV lamps in curing or sterilisation processes.

Both Skye's UVA (SKU 421) and UVB (SKU 430) radiation sensors can be used for monitoring UV levels in any application (primarily sunlight), indoor or outside, and from any light source whether a UV lamp or full solar radiation. They are fully waterproof (IP67 standard) and guaranteed to 4m depth when submerged for 30 minutes.

Our UVI (SKU 440) UV Index radiation sensor are designed to accept radiation that has been identified as being harmful to human skin (the Erythemal Curve) - between 280nm and 400nm. This portion of the spectrum is associated with skin damage such as sunburn and in extreme cases skin cancer. This sensor is ideal for monitoring the harmful effects of solar UV at meteorological stations, or handheld readings using Skye's Apollo meter (SKA 400). Due to calibration technique, this sensor is only useful for measuring solar UV radiation, and not artificial UV sources. It is also fully waterproof (IP67 standard) and guaranteed to 4m depth when submerged for 30 minutes.

As UV radiation levels, especially from natural solar radiation, tend to be very low, then these UV sensors contain a built in amplifier (voltage output or 4-20mA) and are compatible with most datalogger, and controllers.

The sensors are cosine corrected, which means that they accept incoming light according to Lambert's Cosine Law. This means that light is measured from the entire hemisphere directly above the sensor.

2. TYPES OF SENSORS & OPERATION

2.1 UV SENSOR SERIES

Sensor Type:	Voltage Output:	4-20mA Output:
UVA	SKU 421	SKL 2421
UVB	SKU 430	SKL 2430
UVI	SKU 440	-

These sensors have cosine corrected heads, each containing a semi-conductor photodiode and optical filter system responding to light according to the response curves in Appendix 1.

These sensors are completely sealed and can be left in exposed conditions. They are rated IP67 – suitable for temporary immersion (30mins) to depths of 4m.

Each sensor is calibrated against a Reference Sensor under natural sunlight conditions*. The Reference Sensor is traceable to the National Physical Laboratory, the UK's National Standards facility. A traceable Calibration Certificate is provided with each sensor.

**For some environmental chamber customers SKU 421 sensor calibrations use a deuterium lamp as the light source.*

Linearity is excellent with a maximum of 1% deviation up to levels beyond 1500 W m^{-2} (greater than normal solar irradiance).

N.B. The maximum output for some sensors will be limited by the amplifier gain and output voltage limits.

2.2 SENSOR POSITIONING

For accurate measurements, correct positioning of the sensor is essential. We recommend the use of a levelling unit (SKM 222), the sensor is secured using the M6 hole in the base and supplied bolt and washers. Great care should be given to the placing of the sensor, in order to achieve accurate and repeatable results. Avoid objects that will shade the sensor (unless it is permanently shaded, and is relevant to the study). We recommend taking readings facing the sun (so that extraneous objects such as sampling instruments and yourself do not cast a shade over the sensor.

The sensor is fully waterproof - rated to IP67 - and entirely suitable for long term monitoring in all weathers and all environments. We guarantee these sensors to a depth of 4m when submerged for 30 minutes.

Take care to secure the sensor cable to avoid chafing, trapping etc. that may lead to permanent damage of sensor/sensor cable.

2.3 COSINE CORRECTION

Since the sensor is intended to measure light falling on a horizontal plane (i.e. the ground), it is designed to collect light from the whole hemisphere of sky above it. This is why light sensors are cosine corrected. Light rays perpendicular to the sensor are fully measured, while those at 90° are not accepted (they pass parallel to the surface of the plane or the ground and never intercept it). Rays at intermediate angles are treated according to the cosine of their angle to the perpendicular. Imagine the sun overhead, you feel its rays strongest when directly overhead, and much weaker when the sun is near the horizon. The sensor measures light from the different angles in a similar way, stronger when overhead than at low angles.

The cosine response of the sensor is shown in Appendix 2. The cosine errors to an angle of 70° are minimal and are less than 5% to an angle of 80°. The graph shows the actual response of the sensor as a percentage of the ideal response. At 90°, event the most insignificant acceptance of light represents an infinite error, and because of this, accurate plotting beyond 85% is not practical. Errors from such low angle light in nature are generally not material in most studies.

2.4 SENSOR MAINTENANCE

UV sensors require very little maintenance apart from keeping the top light collecting surface (small white diffusing disc) clean and dust free. This can be done using a soft cloth dampened with de-ionised water. Take care not to scratch this surface as this may affect the sensor calibration. The sensor cable should be secured to avoid movement damage or chafing in the wind if used in an outdoor location.

Skye Instruments light sensors and meters are recommended to be calibrated every 2 years. Please return to Skye where the sensor will be calibrated against the reference sensor and a new calibration certificate issued. The calibration change, if any, since last calibration will also be shown on the certificate.

3. SENSOR SPECTRAL RESPONSE

3.1 UVA SENSOR (SKU 421)

The SKU 421 sensor measures approximate UVA radiation between 315-400 nm, as per its spectral response, see spectral response diagram (page 5).

The standard calibrated units for this sensor are Watts per square metre W m^{-2}. Skye offer alternative calibration in units of µmol $m^{-2}s^{-1}$ if required. The standard output range for the SKU 421 is approximately 0-2V = 0-100 W m^{-2}. Other outputs and ranges can also be supplied.

Please see the Calibration Certificate supplied with your sensor for its exact output range and calibrated units. This sensor can be used to measure ultra-violet light from any light source, lamp or from natural solar radiation.

3.2 UVB SENSOR (SKU 430)

The SKU 430 sensor measures approximate UVB radiation between 280-315nm as per its spectral response, see spectral response diagram (page 5).

The standard calibrated units for this sensor are Watts per square metre W m^{-2}. Skye offer alternative calibration in units of µmol $m^{-2}s^{-1}$ if required. The standard output range for the SKU 430 is approximately 0-2V = 0-10 W m^{-2}. Other outputs and ranges can also be supplied.

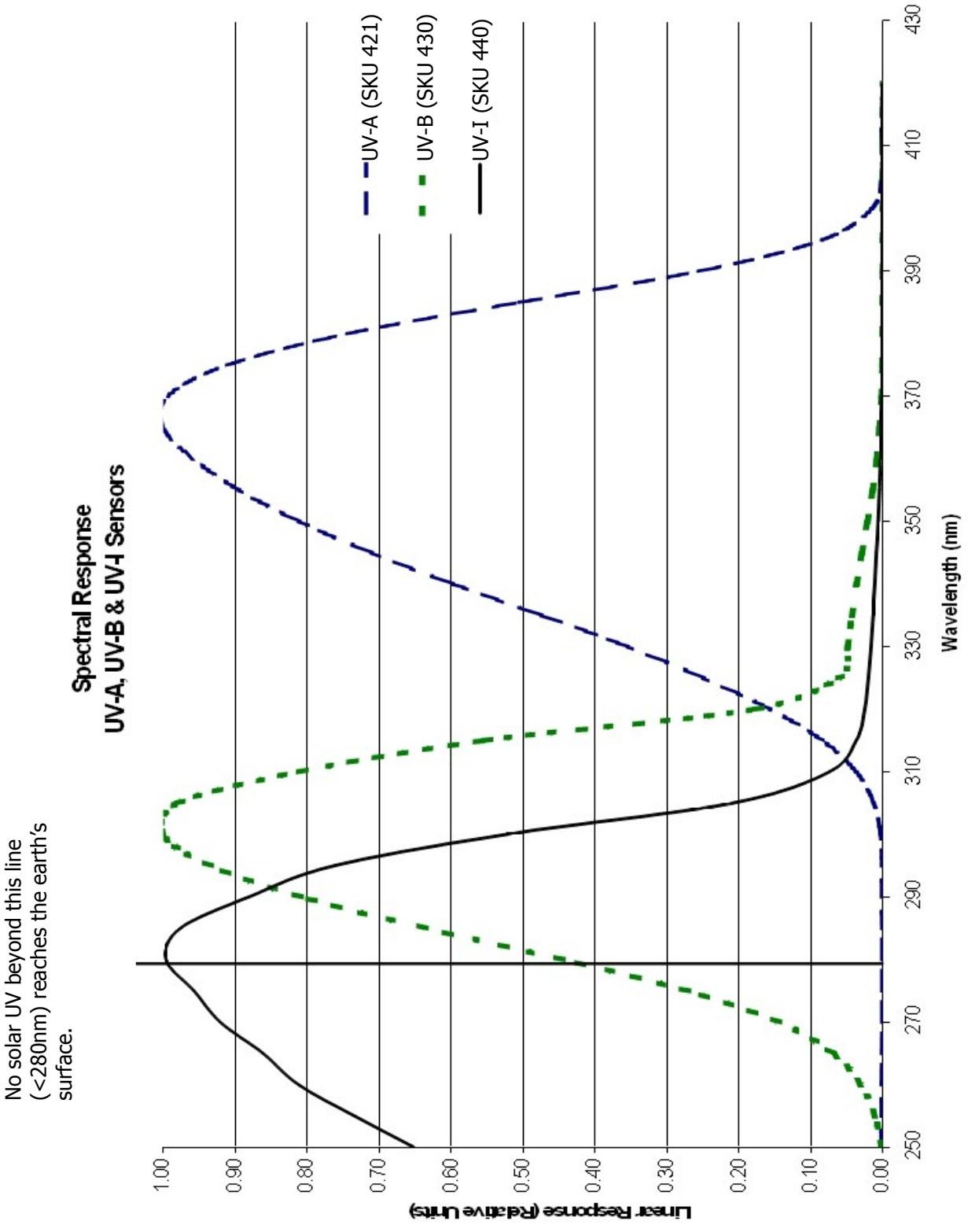
Please see the Calibration Certificate supplied with your sensor for its exact output range and calibrated units. This sensor can be used to measure ultra-violet light from any light source, lamp or from natural solar radiation.

3.3 UVI SENSOR (SKU 440)

The spectral response of the SKU 440 sensor closely matches the Erythemal Action Spectrum between 280nm and 400nm, the region of the solar radiation spectrum usually associated with sunburn and skin cancer (see Appendix 1.) The output range for the SKU 440 is nominally approximately 0-2 V = 0-20 UVI = 0.50 W m^{-2}. Please see the Calibration Certificate supplied with your sensor for its exact output range. Due to the method of calibration, this sensor can be used to measure ultra-violet light from natural solar radiation only.

Note – Please see overleaf for graphical representation of typical spectral responses.

UVA, UVB and UVI Sensors



No solar UV beyond this line (<280nm) reaches the earth's surface.

4. OUTPUTS

Voltage output sensors require a power supply between 5 and 15 volts DC, however the power supply voltage must be increased for sensors with a maximum output >2V (see table below). Current consumption is approximately 1mA, meaning that they can be powered from a logic high output of some computer cards and PLC's (check the specifications of the equipment first).

4-20mA loop current versions require a power supply of 12-36 volts DC.

Sensor Output:	**Power Supply Required:**
Up to 0-2 V	5-15 V DC
Up to 0-5 V	9-15 V DC
Up to 0-10 V	12-15 V DC
4-20 mA	12-36 V DC

The output voltage or loop current is linear with increasing light levels and will rise to a maximum value.

The precise scaling factor is given on the sensor's calibration certificate. Typical sensor outputs are as follows:

Part Number	Description	Sensor Output	Working Range	Typical Value on a summer day
SKU 421 or SKL 2421	UVA	0-2V or 4-20mA	0-100 W m^{-2}	>0-50 W m^{-2}
SKU 430 or SKL 2430	UVB	0-2V or 4-20mA	0-10 W m^{-2}	>0-2 W m^{-2}
SKU 440	UVI	0-2V	0-20 UVI	> 0-11 UVI

Voltage output sensor will have a small zero/dark offset voltage of ±0.2 mV. Even with a 2 V output sensor this represents an error of only 0.01% and can be reasonably ignored. With most systems it will be below the minimum resolution of measurement anyway and thus will not be resolved for measurement, it will appear as zero. If desired and possible, the offset can be measured and subtracted or added to all measurements, since it is a constant offset.

5. CONNECTIONS

The sensor may be supplied wire ended for connection to the user's own equipment, or with a connector fitted for compatibility with Skye's own DataHog or MiniMet datalogger ranges, SpectroSense2 meter range or extension cables.

Part Number Suffix:	Description:
/I	Connector compatible with Skye DataHog2 and Apollo
/SS2	Connector compatible with Skye SpectroSense2 range
/X	Connector compatible with an "EXT" extension cable

5.1 VOLTAGE OUTPUT SENSORS

Great care should be taken not to apply power to the output lead. The output will drive loads with impedance from infinity to around 1kΩ. The output will not be damaged by momentary shorting to the common, but should never, even momentarily be shorted to the supply.

Wire Colour:	Function:	Pin Number (/I and /SS2):	Pin Number (/X):
Red	+ve power supply to sensor (5-15 VDC)	1	1
Green	Sensor -ve output	3	3
Yellow	Sensor +ve output	4	4
Blue	Power supply ground	5	5
White	Cable screen/sensor housing	5	6

5.2 4-20 mA SENSORS

Wire Colour:	Function:	Pin Number (/X):
Red	+ve in	1
Blue	-ve return	2
Green	Cable screen/sensor housing	3

5.3 EXTENSION CABLES

The "EXT" range of extension cables can be used with sensors whose part number includes "/X".

EXT/1 These extension cables are compatible with voltage output sensors. At one end a 7 pin connector is fitted for connection to the sensor. At the other end a pin connector is fitted for connection to a Skye DataHog2, Apollo or SpectroSense2.

EXT/3 These extension cables are compatible with voltage output sensors. At one end a 7 pin connector is fitted for connection to the sensor. At the other 100mm wire tails are left for connection to the users own datalogger, meter or PLC.

Wire Colour:	Function:	Pin Number: (7 pin)	Pin Number: (5 pin)
Black	+ve power supply to sensor (5-15 VDC)	1	1
Red	-	2	2
Yellow	Sensor -ve output	3	3
Green	Sensor +ve output	4	4
Blue	Power supply ground	5	5
White	Cable screen/sensor housing	6	5

EXT/6 These extension cables are compatible with 4-20 mA sensors. At one end a 3 pin connector is fitted for connection to the sensor. At the other 100mm wire tails are left for connection to the users own datalogger, meter or PLC.

Wire Colour:	Function:	Pin Number:
Red	+ve in	1
Blue	-ve return	2
Green	Cable screen/sensor housing	3

6. SPECIFICATIONS

	SKU 421 SKL 2421	SKU 430 SKL 2430	SKU440
Working Range (1)	0-100 W m^{-2}	0-10 W m^{-2}	0-20 UVI
Sensor Passband	See Graphs (page 5)		
Housing	Anodised Black Aluminium, IP67 (fully waterproof – submersible up to 4m for 30mins)		
Dimensions	67mm (h) x 34mm (d)		
Weight	200g (with 3m cable)		
Cable	Voltage output: 7-1-4C military specification 4-20mA: 7-2-2C military specification		
Detector	GaAsP Photodiode	Filtered SiC Photodiode	Filtered SiC Photodiode
Filter	Optical Glass	N/A	N/A
Sensor Output	Voltage output (0-2V standard, customer choice of 0-1V up to 0-10V) or 4-20mA loop current		
Linearity error over working range	<1%		
Absolute Calibration Error (2)	Typically 3%, but <5%		
Cosine Error (3)	3%		
Azimuth Error (4)	<1%		
Temperature Co-efficient	± 0.1%/°C		
Long Term Stability (5)	±2%		
Response Time (6)	<10ms		
Temperature Range	-10 to +60°C	-20 to +70°C	-20 to +70°C
Humidity Range	0-100%RH		
Power Supply Requirements	Voltage output sensors – max output +2V DC 4-20mA loop current sensors require 12-36V DC		

NOTES ON SPECIFICATIONS

(1) All Skye sensors will work at levels of irradiance well above that found in terrestrial sunlight conditions, room or growth chamber lighting. These are default working ranges, check individual calibration certificate.

(2) Main source of this error is uncertainty of calibration of Reference Lamp. Skye calibration standards are directly traceable to NPL standard references.

(3) Cosine error to 80º is typically 5% max. Figures shown are for normal use sources, e.g. sun plus sky, diffuse sun, growth chambers, etc.

(4) Measured at 45º elevation over 360º.

(5) Maximum change in one year. Calibration check recommended at least every two years. Experience has shown that changes are typically much less than figures quoted.

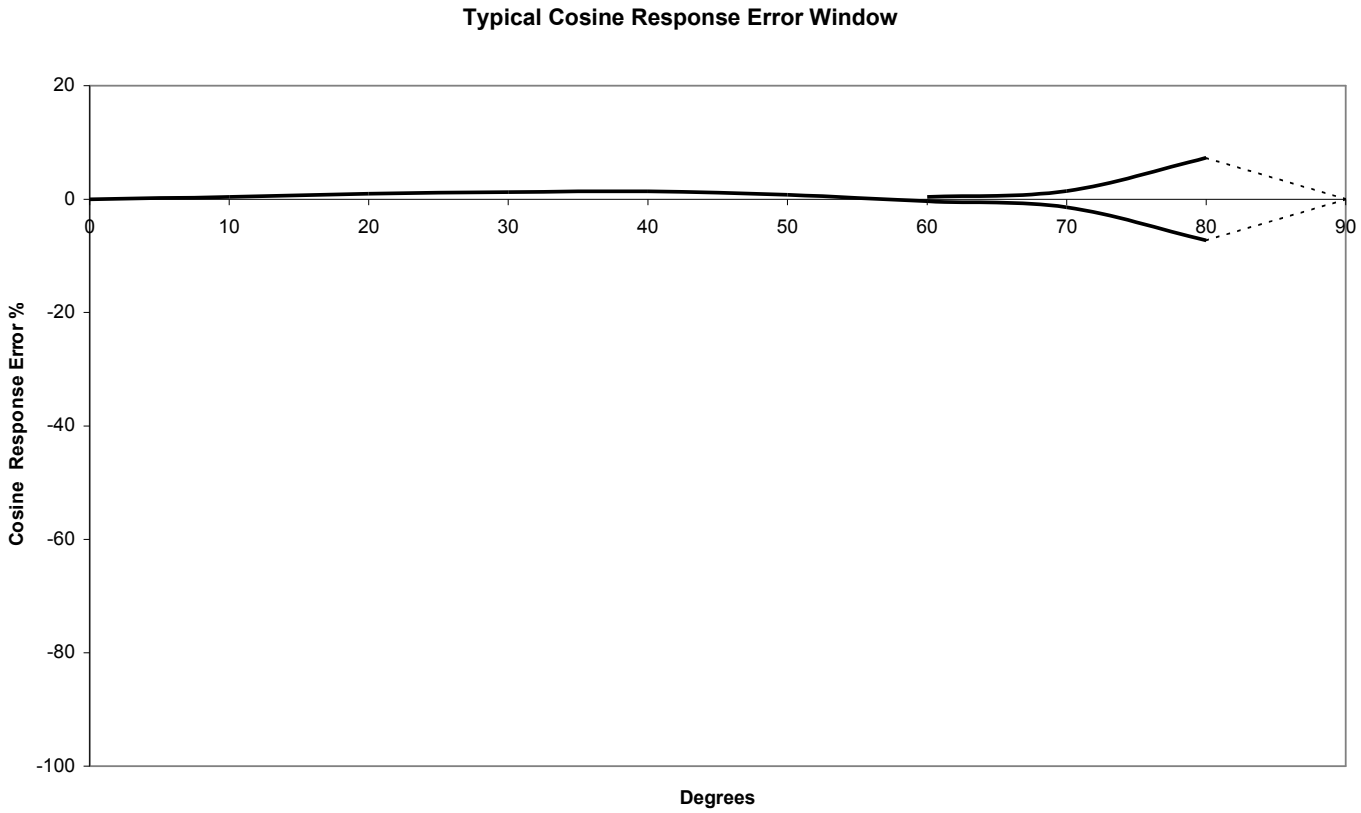
(6) Times are generally less than the figure quoted, which is in milliseconds. They may be slightly increased if long leads are fitted, or those of a higher capacity cable.

APPENDIX 1 – NON-STANDARD PART NUMBERS

PART NUMBER SUFFIXES

/LT	These sensors have been fitted with cable suitable for lower temperatures. Whilst the special cable is rated for use at low temperatures, it is still advisable to avoid undue stress, movement, etc. of the cable when at low temperatures. Wire colours and connections may vary and are shown on a separate wiring sheet.
-20V	These sensors have an output range of 0-5V and require a power supply of 14-20 V DC.
-24V	These sensors have an output range of 0-10V and require a power supply of 23-26 V DC.

APPENDIX 2 – COSINE RESPONSE



APPENDIX 3 - About UV Index

Total Global Radiation is the description of all solar energy falling on the Earth's surface. This energy includes visible light, infra-red energy and ultra-violet radiation. Total Global Radiation is measured in W m^{-2}.

Natural ultra-violet radiation at the Earth's surface has wavelengths between 280 and 400nm. The highest energy radiation, and therefore the most damaging, has the lowest wavelengths. Ultra-violet (UV) radiation is also measured in W m^{-2}.

UVA radiation has wavelengths between 315 and 400nm. UVA is usually associated with skin reddening and sunburn, called Erythema. UVB radiation has higher energy and lower wavelengths between 280 and 315nm, and is usually associated with skin cancer, cataracts and DNA damage.

The UV Index (UVI) is a simple scale of 0-11+ as a measure of UV radiation and an indication to the risk of over-exposure. UVI is related to w m^{-2} by a factor of 40:

$$1 \times UVI = 1/40 \text{ W } m^{-2} \text{ effective UV Erythemal Radiation}$$

Small amounts of UV radiation are essential for humans in producing vitamin D in the skin, but over exposure can seriously damage health.

Levels of UV radiation are highest around solar noon, as you get nearer to the equator, on cloudless days and at altitudes. However UV levels can also be dangerously high in diffuse cloud conditions and also from reflections off snow and ice.

UV INDEX	*EXPOSURE CATEGORY*
Less than 2	Low
3 to 5	Moderate
6 to 7	High
8 to 10	Very High
11+	Extreme

The World Meteorological Organisation (WMO) advises that UV Index should be reported as a single value rounded to the nearest whole number. For a report of the daily maximum UV Index the WMO suggest measurements are taken at 30 minute averages.

For continuous or "live" UV Index reporting, a 5 or 10 minute measurement average may be more useful to display short-term changes. It is also important to report sky conditions, e.g. "clear sky" or "cloud free". WMO guidelines on UV Index and its reporting can be found at www.who.int/uv/publications/globalindex/en/index.html

Useful Links

www.uvmeasuring.com

www.who.int/uv/en

www.sunsmart.org.uk