

# Package ‘photobiologyWavebands’

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**Type** Package

**Title** Waveband Definitions for UV, VIS, and IR Radiation

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**Maintainer** Pedro J. Aphalo <pedro.aphalo@helsinki.fi>

**Description** Constructors of waveband objects for commonly used biological spectral weighting functions (BSWFs) and for different wavebands describing named ranges of wavelengths in the ultraviolet (UV), visible (VIS) and infrared (IR) regions of the electromagnetic spectrum. Part of the 'r4photobiology' suite, Aphalo P. J. (2015) <doi:10.19232/uv4pb.2015.1.14>.

**License** GPL (>= 2)

**VignetteBuilder** knitr

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**Suggests** knitr (>= 1.22), rmarkdown (>= 1.12)

**LazyLoad** yes

**LazyData** yes

**ByteCompile** true

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<https://bitbucket.org/aphalo/photobiologywavebands>

**BugReports** <https://bitbucket.org/aphalo/photobiologywavebands/issues>

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**NeedsCompilation** no

**Author** Pedro J. Aphalo [aut, cre] (<<https://orcid.org/0000-0003-3385-972X>>),  
Titta K. Kotilainen [ctb] (<<https://orcid.org/0000-0002-2822-9734>>)

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photobiologyWavebands-package

*photobiologyWavebands: Waveband Definitions for UV, VIS, and IR Radiation*

---

## Description

Constructors of waveband objects for commonly used biological spectral weighting functions (BSWFs) and for different wavebands describing named ranges of wavelengths in the ultraviolet (UV), visible (VIS) and infrared (IR) regions of the electromagnetic spectrum. Part of the 'r4photobiology' suite, Aphalo P. J. (2015) <doi:10.19232/uv4pb.2015.1.14>.

## Details

This package provides constructors for objects of class waveband from package 'photobiology'. These constructors are based on standard definitions and frequently used non-standardized definitions. When different definitions are in common use for a given named waveband the constructors accept an argument to chose among them. Whenever an ISO standard provides a definition, this is used by default. In the infrared (IR) there are many different definitions and waveband names in use. We have tried to include most of the commonly used names and definitions.

Definitions "matching" the different bands of Landsat imagers are included. These are simple wavelength ranges for wavelengths at half-maximum response as given in the NASA literature, which in some cases presents small inconsistencies. These definitions cannot exactly reproduce instrument responses as they do not describe the real spectral responsiveness of the satellite imagers.

By necessity we cover only a subset of all definitions in use. These should be thought as convenience functions, as waveband objects according to any arbitrary definition can be constructed with the functions provided by package [photobiology-package](#)

## Author(s)

**Maintainer:** Pedro J. Aphalo <pedro.aphalo@helsinki.fi> (0000-0003-3385-972X)

Other contributors:

- Titta K. Kotilainen <titta.kotilainen@helsinki.fi> (0000-0002-2822-9734) [contributor]

## References

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### See Also

Useful links:

- <http://www.r4photobiology.info/>
- <https://bitbucket.org/aphalo/photobiologywavebands>
- Report bugs at <https://bitbucket.org/aphalo/photobiologywavebands/issues>

### Examples

```
q_irrad(sun.spct, PAR()) # PAR photon irradiance
q_irrad(sun.spct, Blue("ISO")) # blue photon irradiance, ISO definition
q_irrad(sun.spct, Blue("Sellaro")) # blue photon irradiance, Sellaro et al.'s definition
e_irrad(sun.spct, VIS()) # VIS irradiance, ISO definition
q_irrad(sun.spct, VIS()) # VIS photon, ISO definition
```

---

Blue

*Constructor of blue waveband*

---

### Description

Default defined according to "ISO".

### Usage

```
Blue(std = "ISO")
```

### Arguments

std                    a character string "ISO", "Sellaro" (plant biology), or "RS" (remote sensing), or Landsat imagers, "LandsatTM", "LandsatETM", or "LandsatOLI".

### Value

a waveband object wavelength defining a wavelength range.

**See Also**

[new\\_waveband waveband](#)

Other unweighted wavebands: [Far\\_red](#), [Green](#), [IR](#), [Orange](#), [Purple](#), [Red](#), [UVA](#), [UVB](#), [UVC](#), [UV](#), [VIS](#), [Yellow](#)

**Examples**

```
Blue()
Blue("ISO")
Blue("Sellaro")
```

---

 CH4

*Constructor of CH4 production from pectin weighted waveband*

---

**Description**

Methane production from pectin BSWF

**Usage**

```
CH4(norm = 300, w.low = 275, w.high = 400)
```

**Arguments**

norm	normalization wavelength (nm)
w.low	short-end boundary wavelength (nm)
w.high	long-end boundary wavelength (nm)

**Value**

a waveband object wavelength defining wavelength range, weighting function and normalization wavelength.

**See Also**

[waveband](#)

Other BSWF weighted wavebands: [CIE](#), [DNA\\_GM](#), [DNA\\_N](#), [DNA\\_P](#), [FLAV](#), [GEN\\_G](#), [GEN\\_M](#), [GEN\\_T](#), [ICNIRP](#), [PG](#)

**Examples**

```
CIE()
CIE(300)
```

---

CH4_e_fun	<i>Gives values for the CH4 production from pectin BSWF as a function of wavelength</i>
-----------	---

---

### Description

This function gives a set of numeric multipliers that can be used as a weight to calculate effective doses and irradiances. The returned values are on quantum based effectiveness relative units.

### Usage

```
CH4_e_fun(w.length)
```

### Arguments

w.length          numeric array of wavelengths (nm)

### Value

a numeric array of the same length as w.length with values for the BSWF normalized as in the original source (300 nm) and based on energy effectiveness.

### References

Bloom, A. A.; Lee-Taylor, J.; Madronich, S.; Messenger, D. J.; Palmer, P. I.; Reay, D. S. & McLeod, A. R. (2010) Global methane emission estimates from ultraviolet irradiation of terrestrial plant foliage. *New Phytologist*, Blackwell Publishing Ltd, 187, 417–425 .

### See Also

Other BSWF functions: [CH4\\_q\\_fun](#), [CIE\\_e\\_fun](#), [CIE\\_q\\_fun](#), [DNA\\_GM\\_q\\_fun](#), [DNA\\_P\\_q\\_fun](#), [FLAV\\_q\\_fun](#), [GEN\\_G\\_q\\_fun](#), [GEN\\_M\\_q\\_fun](#), [GEN\\_T\\_q\\_fun](#), [ICNIRP\\_e\\_fun](#), [PG\\_q\\_fun](#)

### Examples

```
CH4_e_fun(293:400)
```

---

CH4_q_fun	<i>Gives values for the CH4 production from pectin BSWF as a function of wavelength</i>
-----------	---

---

### Description

This function gives a set of numeric multipliers that can be used as a weight to calculate effective doses and irradiances. The returned values are on quantum based effectiveness relative units.

### Usage

```
CH4_q_fun(w.length)
```

### Arguments

w.length          numeric array of wavelengths (nm)

### Value

a numeric array of the same length as w.length with values for the BSWF normalized as in the original source (300 nm) but based on quantum effectiveness.

### See Also

Other BSWF functions: [CH4\\_e\\_fun](#), [CIE\\_e\\_fun](#), [CIE\\_q\\_fun](#), [DNA\\_GM\\_q\\_fun](#), [DNA\\_P\\_q\\_fun](#), [FLAV\\_q\\_fun](#), [GEN\\_G\\_q\\_fun](#), [GEN\\_M\\_q\\_fun](#), [GEN\\_T\\_q\\_fun](#), [ICNIRP\\_e\\_fun](#), [PG\\_q\\_fun](#)

### Examples

```
CH4_q_fun(293:400)
```

---

CIE	<i>Constructor of CIE weighted waveband</i>
-----	---

---

### Description

Erythema BSWF

### Usage

```
CIE(norm = 298, w.low = 250, w.high = 400)
```



**Arguments**

norm	normalization wavelength (nm)
w.low	short-end boundary wavelength (nm)
w.high	long-end boundary wavelength (nm)

**Value**

a waveband object wavelength defining wavelength range, weighting function and normalization wavelength.

**References**

Webb, A. (20XX)

**See Also**

[waveband](#)

Other BSWF weighted wavebands: [CH4](#), [DNA\\_GM](#), [DNA\\_N](#), [DNA\\_P](#), [FLAV](#), [GEN\\_G](#), [GEN\\_M](#), [GEN\\_T](#), [ICNIRP](#), [PG](#)

**Examples**

```
CIE()  
CIE(300)
```

---

CIE1924\_1ef.spct

*CIE1924 luminous efficiency function (photopic human vision)*

---

**Description**

A dataset containing the wavelengths at a 1 nm interval. Tabulated values for quantum luminous efficiency according to CIE1924.

**Format**

A response.spct object with 471 rows and 2 variables

**Details**

The variables are as follows:

- w.length (nm)
- s.q.response

**Note**

This luminous efficiency function underestimates the response to short wavelengths.

**References**

<http://www.cvr1.org/> downloaded on 2015-01-24

---

CIE1951\_scotopic\_lef.spct

*Luminous efficiency function (scotopic human vision)*

---

**Description**

A dataset containing the wavelengths at a 1 nm interval. Tabulated values for quantum luminous efficiency at low light levels according to CIE1951.

**Format**

A response.spct object with 401 rows and 2 variables

**Details**

The variables are as follows:

- w.length (nm)
- s.q.response

**References**

<http://www.cvr1.org/> downloaded on 2015-01-24

---

CIE2008\_lef2deg.spct    *CIE2008 luminous efficiency function (2-deg) (photopic human vision)*

---

**Description**

A dataset containing the wavelengths at a 1 nm interval. Tabulated values for quantum luminous efficiency according to CIE2008 for 2 degrees.

**Format**

A response.spct object with 441 rows and 2 variables

**Details**

The variables are as follows:

- w.length (nm)
- s.q.response

**References**

<http://www.cvr1.org/> downloaded on 2015-01-24

---

CIE\_e\_fun

*Gives values for the erythral BSWF as a function of wavelength*

---

**Description**

This function gives a set of numeric multipliers that can be used as a weight to calculate effective doses and irradiances. The returned values are on quantum based effectiveness relative units.

**Usage**

```
CIE_e_fun(w.length)
```

**Arguments**

w.length          numeric array of wavelengths (nm)

**Value**

a numeric array of the same length as w.length with values for the BSWF normalized as in the original source (298 nm) and based on energy effectiveness.

**See Also**

Other BSWF functions: [CH4\\_e\\_fun](#), [CH4\\_q\\_fun](#), [CIE\\_q\\_fun](#), [DNA\\_GM\\_q\\_fun](#), [DNA\\_P\\_q\\_fun](#), [FLAV\\_q\\_fun](#), [GEN\\_G\\_q\\_fun](#), [GEN\\_M\\_q\\_fun](#), [GEN\\_T\\_q\\_fun](#), [ICNIRP\\_e\\_fun](#), [PG\\_q\\_fun](#)

**Examples**

```
CIE_e_fun(293:400)
```

---

CIE_q_fun	<i>Gives values for the erythemal BSWF as a function of wavelength</i>
-----------	--

---

**Description**

This function gives a set of numeric multipliers that can be used as a weight to calculate effective doses and irradiances. The returned values are on quantum based effectiveness relative units.

**Usage**

```
CIE_q_fun(w.length)
```

**Arguments**

w.length	numeric array of wavelengths (nm)
----------	-----------------------------------

**Value**

a numeric array of the same length as w.length with values for the BSWF normalized as in the original source (298 nm) and based on quantum effectiveness.

**See Also**

Other BSWF functions: [CH4\\_e\\_fun](#), [CH4\\_q\\_fun](#), [CIE\\_e\\_fun](#), [DNA\\_GM\\_q\\_fun](#), [DNA\\_P\\_q\\_fun](#), [FLAV\\_q\\_fun](#), [GEN\\_G\\_q\\_fun](#), [GEN\\_M\\_q\\_fun](#), [GEN\\_T\\_q\\_fun](#), [ICNIRP\\_e\\_fun](#), [PG\\_q\\_fun](#)

**Examples**

```
CIE_q_fun(293:400)
```

---

DNA_GM	<i>Constructor of DNA damage (SETLOW) weighted waveband</i>
--------	---

---

**Description**

Naked DNA damage BSWF, Green and Miller's formulation.

**Usage**

```
DNA_GM(norm = 300, w.low = 275, w.high = 400)
```

**Arguments**

norm	normalization wavelength (nm)
w.low	short-end boundary wavelength (nm)
w.high	long-end boundary wavelength (nm)

**Value**

a waveband object wavelength defining wavelength range, weighting function and normalization wavelength.

**See Also**

[new\\_waveband](#) [waveband](#)

Other BSWF weighted wavebands: [CH4](#), [CIE](#), [DNA\\_N](#), [DNA\\_P](#), [FLAV](#), [GEN\\_G](#), [GEN\\_M](#), [GEN\\_T](#), [ICNIRP](#), [PG](#)

**Examples**

```
DNA_GM()
DNA_GM(300)
```

---

DNA_GM_q_fun	<i>Gives values for naked DNA BSWF (SETLOW) as a function of wavelength</i>
--------------	---

---

**Description**

This function gives a set of numeric multipliers that can be used as a weight to calculate effective doses and irradiances. It uses the seldom used Green and Miller formulation.

**Usage**

```
DNA_GM_q_fun(w.length)
```

**Arguments**

w.length          numeric array of w.length (nm)

**Value**

a numeric array of the same length as w.length with values for the BSWF normalized as in the original source. The returned values are based on quantum effectiveness units.

**See Also**

Other BSWF functions: [CH4\\_e\\_fun](#), [CH4\\_q\\_fun](#), [CIE\\_e\\_fun](#), [CIE\\_q\\_fun](#), [DNA\\_P\\_q\\_fun](#), [FLAV\\_q\\_fun](#), [GEN\\_G\\_q\\_fun](#), [GEN\\_M\\_q\\_fun](#), [GEN\\_T\\_q\\_fun](#), [ICNIRP\\_e\\_fun](#), [PG\\_q\\_fun](#)

**Examples**

```
DNA_GM_q_fun(293:400)
```

---

DNA_N	<i>Constructor of DNA damage (SETLOW) weighted waveband</i>
-------	---

---

**Description**

Naked DNA damage BSWF

**Usage**

DNA\_N(norm = 300, w.low = 275, w.high = 400)

**Arguments**

norm	normalization wavelength (nm)
w.low	short-end boundary wavelength (nm)
w.high	long-end boundary wavelength (nm)

**Value**

a waveband object wavelength defining wavelength range, weighting function and normalization wavelength.

**See Also**

[new\\_waveband](#) waveband

Other BSWF weighted wavebands: [CH4](#), [CIE](#), [DNA\\_GM](#), [DNA\\_P](#), [FLAV](#), [GEN\\_G](#), [GEN\\_M](#), [GEN\\_T](#), [ICNIRP](#), [PG](#)

**Examples**

```
DNA_N()
DNA_N(300)
```

---

DNA_N_q_fun	<i>Gives values for naked DNA BSWF (SETLOW) as a function of wavelength</i>
-------------	---

---

**Description**

This function gives a set of numeric multipliers that can be used as a weight to calculate effective doses and irradiances.

**Usage**

DNA\_N\_q\_fun(w.length)

**Arguments**

w.length          numeric array of w.length (nm)

**Value**

a numeric array of the same length as w.length with values for the BSWF normalized as in the original source. The returned values are based on quantum effectiveness units.

**Note**

The digitized data as used in the TUV model covers the wavelength range from 256 nm to 364 nm. For longer wavelengths we set the value to zero, and for shorter wavelengths we extrapolate the value for 256 nm.

**Examples**

```
DNA_N_q_fun(293:400)
```

---

DNA\_P

*Constructor of DNA damage (Quaite) weighted waveband*

---

**Description**

Plant DNA damage BSWF as formulated by Musil.

**Usage**

```
DNA_P(norm = 300, w.low = 275, w.high = 400)
```

**Arguments**

norm                normalization wavelength (nm)  
w.low                short-end boundary wavelength (nm)  
w.high               long-end boundary wavelength (nm)

**Value**

a waveband object wavelength defining wavelength range, weighting function and normalization wavelength.

**See Also**

[new\\_waveband](#) [waveband](#)

Other BSWF weighted wavebands: [CH4](#), [CIE](#), [DNA\\_GM](#), [DNA\\_N](#), [FLAV](#), [GEN\\_G](#), [GEN\\_M](#), [GEN\\_T](#), [ICNIRP](#), [PG](#)

**Examples**

```
DNA_P()  
DNA_P(300)
```

---

DNA_P_q_fun	<i>Gives values for plant DNA BSWF (Quaite) as a function of wave-length</i>
-------------	--

---

**Description**

This function gives a set of numeric multipliers that can be used as a weight to calculate effective doses and irradiances. It uses the formulation proposed by Musil.

**Usage**

```
DNA_P_q_fun(w.length)
```

**Arguments**

w.length          numeric array of w.length (nm)

**Value**

a numeric array of the same length as w.length with values for the BSWF normalized as in the original source. The returned values are based on quantum effectiveness units.

**See Also**

Other BSWF functions: [CH4\\_e\\_fun](#), [CH4\\_q\\_fun](#), [CIE\\_e\\_fun](#), [CIE\\_q\\_fun](#), [DNA\\_GM\\_q\\_fun](#), [FLAV\\_q\\_fun](#), [GEN\\_G\\_q\\_fun](#), [GEN\\_M\\_q\\_fun](#), [GEN\\_T\\_q\\_fun](#), [ICNIRP\\_e\\_fun](#), [PG\\_q\\_fun](#)

**Examples**

```
DNA_P_q_fun(293:400)
```



---

Far\_red

*Constructor of FR waveband*

---

### Description

Far-red radiation according to "ISO" (not defined) or as commonly defined in plant photobiology, "Smith10" (725-735 nm), "Smith20" (720-740 nm), "Inada" (700-800 nm), "Warrington" (700-850 nm), and "Sellaro" (700-750 nm). The red-edge used in remote sensing of vegetation is centred at the reflectance transition in the far-red band (725 nm), we define "RedEdge40" (705-745 nm) and "RedEdge20" (715-735 nm).

### Usage

```
Far_red(std = "ISO")
```

### Arguments

std	a character string, defaults to "ISO", as for other colour definitions, which in this case returns NA.
-----	--

### Note

The bands are defined as square windows, these can be applied to spectral data but they do not simulate the sensitivity of broad-band sensors or the spectral transmittance of filters. Some band-pass interference filters may have very sharp cut-in and cut-off, and their effect can be approximated by a square window but filters based on light absorption will show gradual tails and bell-shaped wavelength-windows.

### See Also

[NIR](#) for wavebands close to the boundary between red and infrared regions.

[waveband](#)

Other unweighted wavebands: [Blue](#), [Green](#), [IR](#), [Orange](#), [Purple](#), [Red](#), [UVA](#), [UVB](#), [UVC](#), [UV](#), [VIS](#), [Yellow](#)

### Examples

```
Far_red()  
Far_red("ISO")  
Far_red("Smith")
```

---

FLAV

*Constructor of FLAV BSWF flavonoids*

---

### Description

Mesembryanthin accumulation BSWF, data and formulation from Ibdah et al.

### Usage

```
FLAV(norm = 300, w.low = 275, w.high = 346)
```

### Arguments

norm	normalization wavelength (nm)
w.low	short-end boundary wavelength (nm)
w.high	long-end boundary wavelength (nm)

### Value

a waveband object wavelength defining wavelength range, weighting function and normalization wavelength.

### See Also

[waveband](#)

Other BSWF weighted wavebands: [CH4](#), [CIE](#), [DNA\\_GM](#), [DNA\\_N](#), [DNA\\_P](#), [GEN\\_G](#), [GEN\\_M](#), [GEN\\_T](#), [ICNIRP](#), [PG](#)

### Examples

```
FLAV()  
FLAV(300)
```

---

FLAV\_q\_fun

*Gives values for FLAV BSWF (flavonoid) as a function of wavelength*

---

### Description

This function gives a set of numeric multipliers that can be used as a weight to calculate effective doses and irradiances. It is the action spectrum for the accumulation of mesembryanthin.

### Usage

```
FLAV_q_fun(w.length)
```

**Arguments**

w.length            numeric array of w.length (nm)

**Value**

a numeric array of the same length as w.length with values for the BSWF normalized as in the original source. The returned values are based on quantum effectiveness units.

**See Also**

Other BSWF functions: [CH4\\_e\\_fun](#), [CH4\\_q\\_fun](#), [CIE\\_e\\_fun](#), [CIE\\_q\\_fun](#), [DNA\\_GM\\_q\\_fun](#), [DNA\\_P\\_q\\_fun](#), [GEN\\_G\\_q\\_fun](#), [GEN\\_M\\_q\\_fun](#), [GEN\\_T\\_q\\_fun](#), [ICNIRP\\_e\\_fun](#), [PG\\_q\\_fun](#)

**Examples**

```
FLAV_q_fun(293:400)
```

---

GEN_G	<i>Constructor of GPAS (Green) weighted waveband</i>
-------	--

---

**Description**

Generalized Plant Action BSWF of Caldwell as formulated by Green et al.

**Usage**

```
GEN_G(norm = 300, w.low = 275, w.high = 313.3)
```

**Arguments**

norm                normalization wavelength (nm)  
w.low                short-end boundary wavelength (nm)  
w.high                long-end boundary wavelength (nm)

**Value**

a waveband object wavelength defining wavelength range, weighting function and normalization wavelength.

**Note**

In the original publication [2] describing the formulation, the long-end wavelength boundary is specified as 313.3 nm. This is the default used here. However, in some cases it is of interest to vary this limit in sensitivity analyses. The effect on the RAF and doses of changing this boundary is substantial, and has been analysed by Micheletti et al. [3].

## References

- [1] Caldwell, M. M. (1971) Solar UV irradiation and the growth and development of higher plants. In Giese, A. C. (Ed.) *Photophysiology*, Academic Press, 1971, 6, 131-177
- [2] Green, A. E. S.; Sawada, T. & Shettle, E. P. (1974) The middle ultraviolet reaching the ground *Photochemistry and Photobiology*, 1974, 19, 251-259
- [3] Micheletti, M. I.; Piacentini, R. D. & Madronich, S. (2003) Sensitivity of Biologically Active UV Radiation to Stratospheric Ozone Changes: Effects of Action Spectrum Shape and Wavelength Range *Photochemistry and Photobiology*, 78, 456-461

## See Also

[waveband](#)

Other BSWF weighted wavebands: [CH4](#), [CIE](#), [DNA\\_GM](#), [DNA\\_N](#), [DNA\\_P](#), [FLAV](#), [GEN\\_M](#), [GEN\\_T](#), [ICNIRP](#), [PG](#)

## Examples

```
GEN_G()
GEN_G(300)
```

---

GEN_G_q_fun	<i>Gives values for GPAS BSWF (Green's formulation) as a function of wavelength</i>
-------------	---

---

## Description

This function gives a set of numeric multipliers that can be used as a weight to calculate effective doses and irradiances. The BSWF is normalized at 280 nm.

## Usage

```
GEN_G_q_fun(w.length)
```

## Arguments

w.length          numeric array of w.length (nm)

## Value

a numeric array of the same length as w.length with values for the BSWF normalized as in the original source. The returned values are based on quantum effectiveness units.

**Note**

In the original publication [2] describing the formulation, the long-end wavelength boundary is specified as 313.3 nm. The equation is coded here with no such limit so that any limit can be set when defining the waveband. We do so because in some cases it is of interest to vary this limit in sensitivity analyses. The effect on the RAF and doses of changing this boundary is substantial, and has been analysed by Micheletti et al. [3].

**References**

- [1] Caldwell, M. M. (1971) Solar UV irradiation and the growth and development of higher plants. In Giese, A. C. (Ed.) *Photophysiology*, Academic Press, 1971, 6, 131-177
- [2] Green, A. E. S.; Sawada, T. & Shettle, E. P. (1974) The middle ultraviolet reaching the ground *Photochemistry and Photobiology*, 1974, 19, 251-259
- [3] Micheletti, M. I.; Piacentini, R. D. & Madronich, S. (2003) Sensitivity of Biologically Active UV Radiation to Stratospheric Ozone Changes: Effects of Action Spectrum Shape and Wavelength Range *Photochemistry and Photobiology*, 78, 456-461

**See Also**

Other BSWF functions: [CH4\\_e\\_fun](#), [CH4\\_q\\_fun](#), [CIE\\_e\\_fun](#), [CIE\\_q\\_fun](#), [DNA\\_GM\\_q\\_fun](#), [DNA\\_P\\_q\\_fun](#), [FLAV\\_q\\_fun](#), [GEN\\_M\\_q\\_fun](#), [GEN\\_T\\_q\\_fun](#), [ICNIRP\\_e\\_fun](#), [PG\\_q\\_fun](#)

**Examples**

`GEN_G_q_fun(293:400)`

---

GEN\_M

*Constructor of GPAS (Micheletti) weighted waveband*

---

**Description**

Generalized Plant Action BSWF of Caldwell [1] as formulated by Micheletti et al. [2]

**Usage**

`GEN_M(norm = 300, w.low = 275, w.high = 313.3)`

**Arguments**

norm	normalization wavelength (nm)
w.low	short-end boundary wavelength (nm)
w.high	long-end boundary wavelength (nm)

**Value**

a waveband object wavelength defining wavelength range, weighting function and normalization wavelength.

**Note**

In the original publication [2] describing the formulation, the long-end wavelength boundary is specified as 313.3 nm. This is the default used here. However, in some cases it is of interest to vary this limit in sensitivity analyses. The effect on the RAF and doses of changing this boundary is substantial, and has been analysed by Micheletti et al. [3].

**References**

- [1]Caldwell, M. M. (1971) Solar UV irradiation and the growth and development of higher plants. In Giese, A. C. (Ed.) Photophysiology, Academic Press, 1971, 6, 131-177
- [2] Micheletti, M. I.; Piacentini, R. D. & Madronich, S. (2003) Sensitivity of Biologically Active UV Radiation to Stratospheric Ozone Changes: Effects of Action Spectrum Shape and Wavelength Range Photochemistry and Photobiology, 78, 456-461

**See Also**

[new\\_waveband](#) and [waveband](#)

Other BSWF weighted wavebands: [CH4](#), [CIE](#), [DNA\\_GM](#), [DNA\\_N](#), [DNA\\_P](#), [FLAV](#), [GEN\\_G](#), [GEN\\_T](#), [ICNIRP](#), [PG](#)

**Examples**

```
GEN_M()  
GEN_M(300)
```

---

GEN\_M\_q\_fun

*Gives values for GPAS BSWF (Micheletti's formulation) as a function of wavelength*

---

**Description**

This function gives a set of numeric multipliers that can be used as a weight to calculate effective doses and irradiances. The BSWF is normalized at 300 nm.

**Usage**

```
GEN_M_q_fun(w.length)
```

**Arguments**

w.length            numeric array of w.length (nm)

**Value**

a numeric array of the same length as w.length with values for the BSWF normalized as in the original source. The returned values are based on quantum effectiveness units.

**Note**

In the original publication [2] describing the formulation, the long-end wavelength boundary is not specified, but 313.3 nm is usually used. The equation is coded here with the limit at 342 nm as at longer wavelengths the values increase with increasing wavelength. The effect on the RAF and doses of changing this boundary can be substantial, and has been analysed by Micheletti et al. [3].

**References**

- [1]Caldwell, M. M. (1971) Solar UV irradiation and the growth and development of higher plants. In Giese, A. C. (Ed.) Photophysiology, Academic Press, 1971, 6, 131-177
- [2] Micheletti, M. I. and R. D. Piacentini (2002) Irradiancia espectral solar UV-B y su relación con la efectividad de daño biológico a las plantas. ANALES AFA, 13, 242-248
- [3] Micheletti, M. I.; Piacentini, R. D. & Madronich, S. (2003) Sensitivity of Biologically Active UV Radiation to Stratospheric Ozone Changes: Effects of Action Spectrum Shape and Wavelength Range Photochemistry and Photobiology, 78, 456-461

**See Also**

Other BSWF functions: [CH4\\_e\\_fun](#), [CH4\\_q\\_fun](#), [CIE\\_e\\_fun](#), [CIE\\_q\\_fun](#), [DNA\\_GM\\_q\\_fun](#), [DNA\\_P\\_q\\_fun](#), [FLAV\\_q\\_fun](#), [GEN\\_G\\_q\\_fun](#), [GEN\\_T\\_q\\_fun](#), [ICNIRP\\_e\\_fun](#), [PG\\_q\\_fun](#)

**Examples**

```
GEN_M_q_fun(293:400)
```

---

GEN\_T

*Constructor of GPAS (Timijan) weighted waveband*

---

**Description**

Generalized Plant Action BSWF of Caldwell [1] as formulated by Timijan et al. [2]

**Usage**

```
GEN_T(norm = 300, w.low = 275, w.high = 345)
```

**Arguments**

norm	normalization wavelength (nm)
w.low	short-end boundary wavelength (nm)
w.high	long-end boundary wavelength (nm)

**Value**

a waveband object wavelength defining wavelength range, weighting function and normalization wavelength.

**References**

- [1] Caldwell, M. M. (1971) Solar UV irradiation and the growth and development of higher plants. In Giese, A. C. (Ed.) Photophysiology, Academic Press, 1971, 6, 131-177
- [2] Timijan RW, Cams HR, Campbell L. (1978) Radiation sources and related environmental control for biological and climatic effects of UV research. Final report EPA-IAG-D6-0168. Washington: Environmental Protection Agency.

**See Also**

[GEN.G](#) [GEN.M](#) [PG](#) and [waveband](#)

Other BSWF weighted wavebands: [CH4](#), [CIE](#), [DNA\\_GM](#), [DNA\\_N](#), [DNA\\_P](#), [FLAV](#), [GEN\\_G](#), [GEN\\_M](#), [ICNIRP](#), [PG](#)

**Examples**

```
GEN_T()  
GEN_T(300)
```

---

GEN\_T\_q\_fun

*Gives values for GPAS BSWF (Timijan's formulation) as a function of wavelength*

---

**Description**

This function gives a set of numeric multipliers that can be used as a weight to calculate effective doses and irradiances.

**Usage**

```
GEN_T_q_fun(w.length)
```

**Arguments**

w.length          numeric array of w.length (nm)

**Value**

a numeric array of the same length as w.length with values for the BSWF normalized as in the original source. The returned values are based on quantum effectiveness units.



**Note**

For wavelengths shorter than 256 nm the value returned by the equation starts decreasing, but we instead extrapolate this maximum value, obtained at 256 nm, to shorter wavelengths. For wavelengths longer than 345 nm we return zero, as is usual practice.

**See Also**

Other BSWF functions: [CH4\\_e\\_fun](#), [CH4\\_q\\_fun](#), [CIE\\_e\\_fun](#), [CIE\\_q\\_fun](#), [DNA\\_GM\\_q\\_fun](#), [DNA\\_P\\_q\\_fun](#), [FLAV\\_q\\_fun](#), [GEN\\_G\\_q\\_fun](#), [GEN\\_M\\_q\\_fun](#), [ICNIRP\\_e\\_fun](#), [PG\\_q\\_fun](#)

**Examples**

```
GEN_T_q_fun(293:400)
```

---

Green	<i>Constructor of green waveband</i>
-------	--------------------------------------

---

**Description**

Green radiation according to ISO or as commonly defined in plant photobiology, no weighting applied.

**Usage**

```
Green(std = "ISO")
```

**Arguments**

std	a character string "ISO", "Sellaro" or "LandsatRBV", and equivalent names for Landsat imagers.
-----	--

**Value**

a waveband object wavelength defining a wavelength range.

**Note**

When released, this package will replace the package UVcalc.

**See Also**

[waveband](#)

Other unweighted wavebands: [Blue](#), [Far\\_red](#), [IR](#), [Orange](#), [Purple](#), [Red](#), [UVA](#), [UVB](#), [UVC](#), [UV](#), [VIS](#), [Yellow](#)

## Examples

```
Green()  
Green("ISO") # 500 to 570  
Green("Sellaro") # 500 to 570 nm
```

---

ICNIRP

*Constructor of ICNIRP 2004 weighted waveband*

---

## Description

ICNIRP 2004 BSWF waveband constructor. This BSWF is used for the determination of exposure limits (EL) for workers, and includes a safety margin as it is based on eye and the non-pathologic response of the most sensitive human skin types when not tanned.

## Usage

```
ICNIRP(norm = 270, w.low = 210, w.high = 400)
```

## Arguments

norm	normalization wavelength (nm)
w.low	short-end boundary wavelength (nm)
w.high	long-end boundary wavelength (nm)

## Value

a waveband object defining wavelength range, weighting function and normalization wavelength.

## References

INTERNATIONAL COMMISSION ON NON-IONIZING RADIATION PROTECTION (2004) ICNIRP GUIDELINES ON LIMITS OF EXPOSURE TO ULTRAVIOLET RADIATION OF WAVELENGTHS BETWEEN 180 nm AND 400 nm (INCOHERENT OPTICAL RADIATION). HEALTH PHYSICS 87(2):171-186. <https://www.icnirp.org/cms/upload/publications/ICNIRPUV2004.pdf>

## See Also

[new\\_waveband](#) [waveband](#)

Other BSWF weighted wavebands: [CH4](#), [CIE](#), [DNA\\_GM](#), [DNA\\_N](#), [DNA\\_P](#), [FLAV](#), [GEN\\_G](#), [GEN\\_M](#), [GEN\\_T](#), [PG](#)

## Examples

```
ICNIRP()
```

---

 ICNIRP\_e\_fun

*Values for the ICNIRP BSWF as a function of wavelength*


---

### Description

This function returns a vector of numeric multipliers that can be used as a weight to calculate effective doses and irradiances. The returned values are on energy based effectiveness relative units. The BSWF is defined for the range 210 nm to 400 nm.

### Usage

```
ICNIRP_e_fun(w.length)
```

### Arguments

w.length          numeric array of wavelengths (nm)

### Value

a numeric array of the same length as w.length with values for the BSWF normalized as in the original source (270 nm) and based on energy effectiveness.

### See Also

Other BSWF functions: [CH4\\_e\\_fun](#), [CH4\\_q\\_fun](#), [CIE\\_e\\_fun](#), [CIE\\_q\\_fun](#), [DNA\\_GM\\_q\\_fun](#), [DNA\\_P\\_q\\_fun](#), [FLAV\\_q\\_fun](#), [GEN\\_G\\_q\\_fun](#), [GEN\\_M\\_q\\_fun](#), [GEN\\_T\\_q\\_fun](#), [PG\\_q\\_fun](#)

### Examples

```
ICNIRP_e_fun(210:400)
```

---

 IR

*Constructors of infra-red wavebands*


---

### Description

The wavelength limits for std = "RS" and Landsat imagers have been taken from R package RStools and NASA and USGS documentation. They are defined simply as wavelength ranges without considering the spectral sensitivity of satellite instruments/cameras based on which remote sensing based indexes are usually calculated. The values for std = "ISO" are according to ISO 20473. The values for std = "CIE" are suggested values according to Wikipedia, and need verification.

**Usage**

```
IR(std = "ISO")  
NIR(std = "ISO")  
IRA(std = "CIE")  
SWIR(std = "CIE")  
IRB(std = "CIE")  
SWIR1(std = "RS")  
SWIR2(std = "RS")  
MIR(std = "ISO")  
IRC(std = "CIE")  
FIR(std = "ISO")  
TIR1(std = "RS")  
TIR2(std = "RS")
```

**Arguments**

std	character string, "ISO", "CIE", or Landsat imagers named "LandsatRBV", "LandsatMSS", etc., or "RS", for remote sensing wavebands as defined in the documentation of package 'RStoolbox'.
-----	--

**Details**

The names NIR, SWIR and TIR are abbreviations of near infra-red, short-wave infra-red and thermal infra-red, respectively.

**Value**

a waveband object wavelength defining a wavelength range.

**See Also**

[Far\\_red](#) for wavebands close to the boundary between red and infrared regions.

[new\\_waveband](#) [waveband](#)

Other unweighted wavebands: [Blue](#), [Far\\_red](#), [Green](#), [Orange](#), [Purple](#), [Red](#), [UVA](#), [UVB](#), [UVC](#), [UV](#), [VIS](#), [Yellow](#)

**Examples**

```
SWIR1()  
SWIR1("RS")
```

---

IR\_bands

*Constructor of lists of infrared wavebands*

---

**Description**

Defined according to "ISO" or "CIE".

**Usage**

```
IR_bands(std = "ISO")
```

**Arguments**

std                    a character string "ISO" or "CIE".

**Value**

a list of wavebands

**See Also**

[waveband](#)

Other lists of unweighted wavebands: [Landsat\\_bands](#), [Plant\\_bands](#), [UV\\_bands](#), [VIS\\_bands](#)

**Examples**

```
IR_bands()  
IR_bands("ISO")  
IR_bands("CIE")
```

---

Landsat_bands	<i>Constructor of lists of wavebands matching Landsat imagers</i>
---------------	---

---

### Description

Defined according as ranges of wavelengths according to NASA and USGS manuals. The definitions are as *rectangular* windows, while the true response functions deviate to some extent from these ideal definitions.

### Usage

```
Landsat_bands(std = "L8")  
  
RBV_bands(std = "LandsatRBV")  
  
MSS_bands(std = "LandsatMSS")  
  
OLI_bands(std = "LandsatOLI")  
  
TIRS_bands(std = "LandsatTIRS")  
  
ETM_bands(std = "LandsatETM")
```

### Arguments

std	a character string "L1"..."L8", for missions, "LandsatRBV", "LandsatMSS", etc. for imagers.
-----	---

### Details

See <https://landsat.usgs.gov/spectral-characteristics-viewer> for detailed sensitivity spectra for the different bands of the imaginers.

### Value

a list of wavebands

### See Also

[waveband](#)

Other lists of unweighted wavebands: [IR\\_bands](#), [Plant\\_bands](#), [UV\\_bands](#), [VIS\\_bands](#)

### Examples

```
Landsat_bands("L1")  
Landsat_bands("L8")  
OLI_bands()  
TIRS_bands()
```



**Value**

a waveband object wavelength defining a wavelength range.

**References**

McCree, K. J. (1972) The action spectrum, absorptance and quantum yield of photosynthesis in crop plants. *Agricultural Meteorology*, 9, 191-216

**See Also**

[waveband](#)

**Examples**

```
PAR()
PAR("Plant")
```

---

 PG

---

*Constructor of PG weighted waveband*


---

**Description**

Plant growth BSWF

**Usage**

```
PG(norm = 300, w.low = 275, w.high = 390)
```

**Arguments**

norm	normalization wavelength (nm)
w.low	short-end boundary wavelength (nm)
w.high	long-end boundary wavelength (nm)

**Value**

a waveband object wavelength defining wavelength range, weighting function and normalization wavelength.



**Note**

In the original publication [1], the long-end wavelength boundary is not specified. the longest wavelength at which the plant response was measured is 366 nm. From the data there is no evidence that action would immediately drop to zero at longer wavelengths. We have used in earlier versions the same value as used by the 'NSF Polar Programs UV Monitoring Network' as described in <http://uv.biospherical.com/Version2/description-Version2-Database3.html>. Now we keep 390 nm as our default value, but make if possible for the user to set a different wavelength. To reproduce the output of the TUV simulation model [3] version 5.0 set `w.high = 366`.

In contrast to the NSF Network, for example, the programme TUV uses 366 nm as the limit, so for comparing results one may need to adjust the value of this parameter. The effect on the RAF and doses of changing this wavelength boundary is substantial, as discussed by Micheletti et al. [2].

**References**

[1] Flint, S. and Caldwell M. M. (2003) A biological spectral weighting function for ozone depletion research with higher plants *Physiologia Plantarum*, 2003, 117, 137-144

[2] Micheletti, M. I.; Piacentini, R. D. & Madronich, S. (2003) Sensitivity of Biologically Active UV Radiation to Stratospheric Ozone Changes: Effects of Action Spectrum Shape and Wavelength Range *Photochemistry and Photobiology*, 78, 456-461

[3] <https://www2.acom.ucar.edu/modeling/tropospheric-ultraviolet-and-visible-tuv-radiation-model>

**See Also**

[GEN\\_G](#) [GEN\\_T](#) [GEN\\_M](#) and [waveband](#)

Other BSWF weighted wavebands: [CH4](#), [CIE](#), [DNA\\_GM](#), [DNA\\_N](#), [DNA\\_P](#), [FLAV](#), [GEN\\_G](#), [GEN\\_M](#), [GEN\\_T](#), [ICNIRP](#)

**Examples**

```
PG()
PG(300)
```

---

PG\_q\_fun

*Gives values for the Plant Growth BSWF as a function of wavelength*

---

**Description**

This function gives a set of numeric multipliers that can be used as a weight to calculate effective doses and irradiances. The returned values are on quantum based effectiveness relative units.

**Usage**

```
PG_q_fun(w.length)
```

**Arguments**

w.length          numeric array of wavelengths (nm)

**Value**

a numeric array of the same length as w.length with values for the BSWF normalized as in the original source (300 nm)

**Note**

We follow the original definition here for the equation, with no limitation to the wavelength range. However, be aware that in practice it is not used for long wavelengths (different limits between 366 nm and 400 nm have been used by different authors).

**See Also**

Other BSWF functions: [CH4\\_e\\_fun](#), [CH4\\_q\\_fun](#), [CIE\\_e\\_fun](#), [CIE\\_q\\_fun](#), [DNA\\_GM\\_q\\_fun](#), [DNA\\_P\\_q\\_fun](#), [FLAV\\_q\\_fun](#), [GEN\\_G\\_q\\_fun](#), [GEN\\_M\\_q\\_fun](#), [GEN\\_T\\_q\\_fun](#), [ICNIRP\\_e\\_fun](#)

**Examples**

```
PG_q_fun(293:400)
```

---

photopic\_sensitivity    *Photopic sensitivity of the human eye*

---

**Description**

Constant value used in the definition of Lumen 1 Lumen is equal to 683 W at 555 nm

**Usage**

```
photopic_sensitivity
```

**Format**

A single numeric value

**Details**

A single numeric value

---

Plant_bands	<i>Constructor of lists of wavebands used in plant biology</i>
-------------	--

---

**Description**

Defined according to different authors.

**Usage**

```
Plant_bands(std = "sensory20")
```

**Arguments**

std                    a character string "sensory", "sensory10", "sensory20", "ISO", "CIE", "none" or "", where "ISO", "CIE" and "none" affect only the UV bands.

**Value**

a list of wavebands

**See Also**

[waveband](#)

Other lists of unweighted wavebands: [IR\\_bands](#), [Landsat\\_bands](#), [UV\\_bands](#), [VIS\\_bands](#)

**Examples**

```
Plant_bands()  
Plant_bands("sensory")  
Plant_bands("sensory10")  
Plant_bands("sensory20")  
Plant_bands("ISO")  
Plant_bands("CIE")
```

---

Purple	<i>Constructor of purple waveband</i>
--------	---------------------------------------

---

**Description**

Purple radiation (360...450 nm), no weighting applied.

**Usage**

```
Purple(std = "ISO")
```

**Arguments**

`std` a character string "ISO", or Landsat imager "LandsatOLI".

**Value**

A waveband object wavelength defining a wavelength range.

**See Also**

[new\\_waveband](#) [waveband](#)

Other unweighted wavebands: [Blue](#), [Far\\_red](#), [Green](#), [IR](#), [Orange](#), [Red](#), [UVA](#), [UVB](#), [UVC](#), [UV](#), [VIS](#), [Yellow](#)

**Examples**

```
Purple()
Purple("ISO")
```

---

Red

*Constructor of red waveband*

---

**Description**

Red radiation according to "ISO" (610-760 nm) or as commonly defined in plant photobiology, "Smith10" (655-665 nm), "Smith20" (650-670 nm), "Inada" (600-700 nm), "Warrington" (625-675 nm), and "Sellaro" (620-680 nm). No weighting applied.

**Usage**

```
Red(std = "ISO")
```

**Arguments**

`std` a character string, "ISO", "Smith10", "Smith20", "Inada", "Warrington", "Sellaro", "RS", or for Landsat imagers "LandsatRBV", etc.

**Value**

a waveband object wavelength defining a wavelength range.

## References

Aphalo, P. J., Albert, A., Björn, L. O., McLeod, A. R., Robson, T. M., Rosenqvist, E. (Eds.). (2012). *Beyond the Visible: A handbook of best practice in plant UV photobiology* (1st ed., p. xxx + 174). Helsinki: University of Helsinki, Department of Biosciences, Division of Plant Biology. ISBN 978-952-10-8363-1 (PDF), 978-952-10-8362-4 (paperback). Open access PDF download available at <https://hdl.handle.net/10138/37558>

ISO (2007) *Space environment (natural and artificial) - Process for determining solar irradiances*. ISO Standard 21348. ISO, Geneva.

Murakami, K., Aiga I. (1994) Red/Far-red photon flux ratio used as an index number for morphological control of plant growth under artificial lighting conditions. *Proc. Int. Symp. Artificial Lighting, Acta Horticulturae*, 418, ISHS 1997.

Sellaro, R., Crepy, M., Trupkin, S. A., Karayekov, E., Buchovsky, A. S., Rossi, C., & Casal, J. J. (2010). Cryptochrome as a sensor of the blue/green ratio of natural radiation in *Arabidopsis*. *Plant physiology*, 154(1), 401-409. doi:10.1104/pp.110.160820

Smith, H. (1982) Light quality, photoperception and plant strategy. *Annual Review of Plant Physiology*, 33:481-518.

## See Also

[waveband](#)

Other unweighted wavebands: [Blue](#), [Far\\_red](#), [Green](#), [IR](#), [Orange](#), [Purple](#), [UVA](#), [UVB](#), [UVC](#), [UV](#), [VIS](#), [Yellow](#)

## Examples

```
Red()  
Red("ISO")  
Red("Smith")  
Red("Sellaro")
```

---

scotopic\_sensitivity    *Scotopic sensitivity of the human eye*

---

## Description

Constant value for human vision under very weak illumination 1 Lumen is equal to 1699 W at 507 nm

## Usage

```
scotopic_sensitivity
```

## Format

A single numeric value

**Details**

A single numeric value

---

SetlowTUV.spct	<i>Setlow's action spectrum for DNA damage</i>
----------------	--

---

**Description**

A dataset containing the wavelengths at a 0.1 nm interval. Tabulated values for Setlow's naked DNA damage action spectrum as used in the TUV model.

**Format**

A response.spct object with 1082 rows and 2 variables

**Details**

The variables are as follows:

- w.length (nm)
- s.e.response

**References**

<http://uv.biospherical.com/Version2/description-Version2-Database3.html> downloaded 2015-02-07

---

UV	<i>Constructor of UV waveband</i>
----	-----------------------------------

---

**Description**

UV: 100–400 nm.

**Usage**

UV(std = "ISO")

**Arguments**

std                    "ISO" or "CIE"

**Value**

a waveband object wavelength defining a wavelength range.

**References**

ISO and CIE standards

**See Also**

[new\\_waveband](#) [waveband](#)

Other unweighted wavebands: [Blue](#), [Far\\_red](#), [Green](#), [IR](#), [Orange](#), [Purple](#), [Red](#), [UVA](#), [UVB](#), [UVC](#), [VIS](#), [Yellow](#)

**Examples**

```
UV()  
UV("ISO")
```

---

UVA

*Constructor of UV-A waveband*

---

**Description**

UV-A according to CIE and ISO standards: 315–400 nm. UV-A according to common non-standard practice: 320–400 nm. UV-A1 according to CIE: 315–340 nm. UV-A2 according to CIE: 340–400 nm. UVsw according to non-standard use suitable for plants: 315–350 nm. UVlw according to non-standard use suitable for plants: 350–400 nm.

**Usage**

```
UVA(std = "ISO")  
  
UVA1(std = "CIE")  
  
UVA2(std = "CIE")  
  
UVAsw(std = "plants")  
  
UVAlw(std = "plants")
```

**Arguments**

`std` a character string "CIE", "ISO" or "none"

**Value**

a waveband object wavelength defining a wavelength range.

**See Also**

[waveband](#)

Other unweighted wavebands: [Blue](#), [Far\\_red](#), [Green](#), [IR](#), [Orange](#), [Purple](#), [Red](#), [UVB](#), [UVC](#), [UV](#), [VIS](#), [Yellow](#)

**Examples**

```
UVA()  
UVA("none")  
UVA("ISO")  
UVA("CIE")  
UVA1()  
UVA1("CIE")  
UVA2()  
UVA2("CIE")
```

---

UVB

*Constructor of UV-B waveband*

---

**Description**

UV-B according to CIE and ISO standrads: 280–315 nm. UV-B according to common non-standard practice: 280–320 nm. UV-B according to medical or dermatological non-standard practice: 280–320 nm.

**Usage**

```
UVB(std = "ISO")
```

**Arguments**

std                    a character string "CIE", "ISO", "medical" or "none"

**Value**

a waveband object wavelength defining a wavelength range.

**See Also**

[waveband](#)

Other unweighted wavebands: [Blue](#), [Far\\_red](#), [Green](#), [IR](#), [Orange](#), [Purple](#), [Red](#), [UVA](#), [UVC](#), [UV](#), [VIS](#), [Yellow](#)



**Examples**

```
UVB()  
UVB("ISO")  
UVB("CIE")  
UVB("none")  
UVB("medical")
```

---

UVC

*Constructor of UV-C waveband*

---

**Description**

UV-C according to CIE and ISO standrads: 100–280 nm. UV-c according to common non-standard practice: 200–280 nm. UV-C according to medical or dermatological non-standard practice, e.g. Diffey (1991): 200–290 nm.

**Usage**

```
UVC(std = "ISO")
```

**Arguments**

std                    a character string "CIE", "ISO", "none", or "medical".

**Value**

a waveband object wavelength defining a wavelength range.

**See Also**

[new\\_waveband waveband](#)

Other unweighted wavebands: [Blue](#), [Far\\_red](#), [Green](#), [IR](#), [Orange](#), [Purple](#), [Red](#), [UVA](#), [UVB](#), [UV](#), [VIS](#), [Yellow](#)

**Examples**

```
UVC()  
UVC("CIE")  
UVC("ISO")  
UVC("none")  
UVC("medical")
```

---

UVI *Calculate UVI from spectral irradiance*

---

### Description

UVI (UV Index) is a unitless quantity based on erythema BSWF, that gives an easy to interpret UV measure, mainly meant for informing general public about sunburn risk.

### Usage

```
UVI(spct, std = "NOAA")
```

### Arguments

spct	a source.spct object
std	"WMO" (250 nm to 400 nm), "NOAA" (286.5 nm to 400 nm)

### Details

Two different definitions of UV Index are implemented in this package. Setting `std="NOAA"` follows the definition in Kiedron et al. (2007) but using CIE98 as SWF. NOAA definition discards wavelengths shorter than 286.5 nm as when calculated based on spectral data from Brewer instruments. "WMO" uses the internationally accepted lower limit at 250 nm (see WHO, 2002). "NOAA" is the default as this is safer with noisy data for solar radiation measured at ground level, and in this case the value of UVI should be correct, and almost identical except for errors caused by noise at shorter wavelengths. However, when calculating UVI from radiation spectra from UV lamps, "WMO" should be used, as most UV lamps do emit some radiation between 250 nm and 286.5 nm.

### Value

a numeric value for the unitless UVI (This is a value on a continuous scale, rather than the discrete scale normally used.)

### References

WHO (2002) Global Solar UV Index: A Practical Guide. ISBN 92 4 159007 6, WHO, Geneva. <https://www.who.int/uv/publications/globalindex/en/> or [http://uv.biospherical.com/Solar\\_Index\\_Guide.pdf](http://uv.biospherical.com/Solar_Index_Guide.pdf).

P. Kiedron, S. Stierle and K. Lantz (2007) Instantaneous UV Index and Daily UV Dose Calculations. NOAA-EPA Brewer Network. <https://www.esrl.noaa.gov/gmd/grad/neubrew/docs/UVindex.pdf>

### Examples

```
UVI(sun.spct)
UVI(sun.spct, "WMO")
round(UVI(sun.spct), 0)
```

---

**UV\_bands***Constructor of lists of UV wavebands*

---

**Description**

Defined according to "ISO" by default, but other definitions also supported.

**Usage**

```
UV_bands(std = "ISO")
```

**Arguments**

std                    a character string "ISO", "CIE", "medical", "plants" or "none".

**Value**

a list of wavebands

**See Also**

[waveband](#)

Other lists of unweighted wavebands: [IR\\_bands](#), [Landsat\\_bands](#), [Plant\\_bands](#), [VIS\\_bands](#)

**Examples**

```
UV_bands()  
UV_bands("ISO")  
UV_bands("CIE")  
UV_bands("medical")  
UV_bands("plants")  
UV_bands("none")
```

---

**VIS***Constructor of VIS waveband*

---

**Description**

Visible (to humans) radiation (380...760 nm) according to ISO standard definition, no weighting applied. For std = "RS" the returned range is the same as for PAR().

**Usage**

```
VIS(std = "ISO")
```

**Arguments**

std                    a character string "ISO" or "RS" (remote sensing).

**Value**

A waveband object wavelength defining a wavelength range.

**See Also**

[waveband](#)

Other unweighted wavebands: [Blue](#), [Far\\_red](#), [Green](#), [IR](#), [Orange](#), [Purple](#), [Red](#), [UVA](#), [UVB](#), [UVC](#), [UV](#), [Yellow](#)

**Examples**

```
VIS()  
VIS("ISO")
```

---

VIS\_bands

*Constructor of lists of VIS wavebands*

---

**Description**

Defined according to "ISO".

**Usage**

```
VIS_bands(std = "ISO")
```

**Arguments**

std                    a character string "ISO".

**Value**

a list of wavebands

**See Also**

Other lists of unweighted wavebands: [IR\\_bands](#), [Landsat\\_bands](#), [Plant\\_bands](#), [UV\\_bands](#)

**Examples**

```
VIS_bands()  
VIS_bands("ISO")
```

---

Yellow	<i>Constructor of yellow waveband</i>
--------	---------------------------------------

---

**Description**

Yellow radiation (570...591 nm), no weighting applied.

**Usage**

```
Yellow(std = "ISO")
```

**Arguments**

std                    a character string "ISO"

**Value**

a waveband object wavelength defining a wavelength range.

**See Also**

[waveband](#)

Other unweighted wavebands: [Blue](#), [Far\\_red](#), [Green](#), [IR](#), [Orange](#), [Purple](#), [Red](#), [UVA](#), [UVB](#), [UVC](#), [UV](#), [VIS](#)

**Examples**

```
Yellow()  
Yellow("ISO")
```

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