Package ‘photobiologyWavebands’

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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.

Details

This package provides constructors for objects of class waveband from package 'photobiology'. These contractors 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 responsivenes 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)

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Other contributors:

- Titta K. Kotilainen <titta.kotilainen@helsinki.fi> [contributor]
References


Green, A. E. S., Miller, J. H. (1975) Measures of biologically active radiation in the 280-340 nm region. Impacts of climate change on the environment. CIAP Monograph, 5, Part 1, Chapter 2.2.4


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

Examples

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

---

**CH4**

*Constructor of CH4 production from pectin weighted waveband*

Description

Methane production from pectin BSWF

Usage

```r
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

```r
CIE()
CIE(300)
```
**CH4_e_fun**

Gives values for the CH4 production from pectin 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**

```r
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**


**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**

```r
CH4_e_fun(293:400)
```
CH4_q_fun  

*Gives values for the CH4 production from pectin 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**

```r
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**

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

---

**CIE**  

*Constructor of CIE weighted waveband*

---

**Description**

Erythema BSWF

**Usage**

```r
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

```r
cIE()
cIE(300)
```

---

**CIE1924_lef.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.cvrl.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.cvrl.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.cvrl.org/ downloaded on 2015-01-24

---

**CIE_e_fun**

*Gives values for the erythemal 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**

*Gives values for the erythemal 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_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**

*Constructor of DNA damage (SETLOW) weighted waveband*

**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)
DNA_GM_q_fun

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_gmHI
dna_gmHSPPI

gives values for naked DNA BSWF (SETLOW) 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 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

Constructor of DNA damage (SETLOW) weighted waveband

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

* Gives values for naked DNA BSWF (SETLOW) 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
DNA_N_q_fun(w.length)
**DNA_P**

**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**

```r
DNA_N_q_funHRYS:TPPI
dna_p
```

**Description**

Plant DNA damage BSWF as formulated by Musil.

**Usage**

```r
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**

```r
dNA_P(5)
dNA_P(300)
```

---

**DNA_P_q_fun**

*Gives values for plant DNA BSWF (Quaite) 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 uses the formulation proposed by Musil.

**Usage**

```r
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**

```r
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). No weighting applied.

Usage

Far_red(std = "ISO")

Arguments

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

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

```r
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 mesembrathin.

Usage

```r
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**

*Constructor of GPAS (Green) weighted waveband*

**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**


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**

*Gives values for GPAS BSWF (Green’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 280 nm.

**Usage**

```r
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


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_M.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

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
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<tr>
<td>norm</td>
<td>normalization wavelength (nm)</td>
</tr>
<tr>
<td>w.low</td>
<td>short-end boundary wavelength (nm)</td>
</tr>
<tr>
<td>w.high</td>
<td>long-end boundary wavelength (nm)</td>
</tr>
</tbody>
</table>

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


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)

\begin{verbatim}
GEN\_M\_q\_fun
\end{verbatim}

\textit{Gives values for GPAS BSWF (Micheletti’s formulation) as a function of wavelength}

\textbf{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.

\textbf{Usage}

\texttt{GEN\_M\_q\_fun(w\_length)}

\textbf{Arguments}

\texttt{w\_length} numeric array of w\_length (nm)

\textbf{Value}

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

\textbf{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


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

```r
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


See Also

GEN.T, 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 wavelength (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**

*Constructor of green waveband*

---

**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


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()
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
IR_bands

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

Constructor of lists of wavebands matching Landsat imagers

Description

Defined according as ranges of wavelengths according to NASA and USGS manuals.

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, "LandsarRBV", "LandsatMSS", etc. for imagers.

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()
Orange

Constructor of orange waveband

Description
Orange radiation (591...610 nm), no weighting applied.

Usage
Orange(std = "ISO")

Arguments
std a character string "ISO"

Value
a waveband object wavelength defining a wavelength range.

See Also
Other unweighted wavebands: Blue, Far_red, Green, IR, Purple, Red, UVA, UVB, UVC, UV, VIS, Yellow

Examples
Orange()
Orange("ISO")

PAR
Constructor of PAR waveband

Description
Photosynthetically active radiation (400-700 nm), no weighting applied.

Usage
PAR(std = "Plant")

Arguments
std a character string "Plant" or "McCree"
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

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>norm</td>
<td>normalization wavelength (nm)</td>
</tr>
<tr>
<td>w.low</td>
<td>short-end boundary wavelength (nm)</td>
</tr>
<tr>
<td>w.high</td>
<td>long-end boundary wavelength (nm)</td>
</tr>
</tbody>
</table>

Value

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

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 [1]. Now we keep 390 nm as our default value, but make it possible for the user to set a different wavelength. To reproduce the output of the TUV simulation model [3] version 5.0 set \( w\text{.high} = 366 \).

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


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)
```
photopic_sensitivity

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

Constructor of lists of wavebands used in plant biology

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

Constructor of purple waveband

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")

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


Value

a waveband object wavelength defining a wavelength range.
References


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**  
*Setlow’s action spectrum for DNA damage*

---

**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**


---

**UV**  
*Constructor of UV waveband*

---

**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


Usage

UVA(std = "ISO")
UVA1(std = "CIE")
UVA2(std = "CIE")

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 standards: 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 standards: 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

```r
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

```r
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

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

spct a source.spct object
std "WWO" (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


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".

Usage

UV_bands(std = "ISO")
**Arguments**

`std` a character string "ISO", "CIE", "medical" 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("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**

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

**Description**

Contractor of lists of VIS wavebands

Defined according to "ISO".

**Usage**

```r
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**

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

---

**Yellow**

Constructor of yellow waveband

**Description**

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

**Usage**

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

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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