

# Package ‘photobiologySun’

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**Type** Package

**Title** Data for Sunlight Spectra

**Version** 0.4.1

**Date** 2019-03-27

**Description** Data for the extraterrestrial solar spectral irradiance and ground level solar spectral irradiance and irradiance. In addition data for shade light under vegetation and irradiance time series. Part of the ‘r4photobiology’ suite, Aphalo P. J. (2015) <[doi:10.19232/uv4pb.2015.1.14](https://doi.org/10.19232/uv4pb.2015.1.14)>.

**License** GPL (>= 2)

**VignetteBuilder** knitr

**Depends** R (>= 3.4.0), photobiology (>= 0.9.26)

**Suggests** knitr (>= 0.1.22), rmarkdown (>= 1.12), photobiologyWavebands (>= 0.4.2), ggplot2 (>= 3.1.0), ggspectra (>= 0.3.2), lubridate (>= 1.7.4)

**LazyLoad** yes

**LazyData** yes

**ByteCompile** true

**Encoding** UTF-8

**URL** <http://www.r4photobiology.info>,  
<https://bitbucket.org/aphalo/photobiologySun>

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

**RoxygenNote** 6.1.1

**NeedsCompilation** no

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**Repository** CRAN

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photobiologySun-package

*photobiologySun: Data for Sunlight Spectra*

## Description

Data for the extraterrestrial solar spectral irradiance and ground level solar spectral irradiance and irradiance. In addition data for shade light under vegetation and irradiance time series. Part of the 'r4photobiology' suite, Aphalo P. J. (2015) <doi:10.19232/uv4pb.2015.1.14>.

## Author(s)

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## 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>

Aphalo, Pedro J. (2015) The r4photobiology suite. UV4Plants Bulletin, 2015:1, 21-29. <https://doi.org/10.19232/uv4pb.2015.1.14>.  
<https://www.nrel.gov/rredc/> <https://www.astm.org/>

### See Also

Useful links:

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

### Examples

```
library(photobiology)
library(photobiologyWavebands)

q_irrad(sun_may_morning.spct, PAR())
q_ratio(sun_may_morning.spct, Red("Smith10"), Far_red("Smith10"))
```

---

gap.mspct

*Solar spectral irradiance in a tree canopy gap (measured)*

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### Description

A dataset containing a sequence of 72 spectra measured with an Ocean Optics Maya2000 Pro spectrometer and a Bentham DH-7-SM cosine diffuser. Values measured on 30 April 2014, in the late morning, under clear sky conditions. The whole sequence was measured in 39 seconds in a sunfleck under young silver birch trees. Place: University of Helsinki, Viikki Campus, Finland. Coordinates: 60.227162 N, 25.019429 E. Calibration and corrections done with package MayaCalc using bracketing and noise reduction (with filter measurement) and method "sun". Algorithm and calibration data by Lasse Ylianttila (STUK, Helsinki, Finland).

### Usage

```
gap.mspct
```

### Format

A source\_mspct object containing a collection of 72 source\_spct objects.

### Details

- w.length (nm), range 293 to 800 nm.
- s.e.irrad (W m<sup>-2</sup> nm<sup>-1</sup>)

**Author(s)**

T. Matthew Robson and Saara Hartikainen (data)

**References**

Ylianttila, L.; Visuri, R.; Huurto, L. & Jokela, K. (2005) Evaluation of a single-monochromator diode array spectroradiometer for sunbed UV-radiation measurements. *Photochem Photobiol*, 81, 333-341

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irrad\_Kipp.data      *Ground level solar irradiance (measured)*

---

**Description**

Dataset containing mean, maximum, minimum and standard deviation values for global radiation data expressed as (energy) irradiance. Each value is a summary 60 consecutive readings acquired once every second.

**Usage**

irrad\_Kipp.data

**Format**

A data frame with 24479 rows and 5 variables. variables.

**Details**

The variables are as follows:

- time\_EEST POSIXct Local time according to EET coordinates.
- e\_irrad\_mean numeric (W m-2)
- e\_irrad\_min numeric (W m-2)
- e\_irrad\_max numeric (W m-2)
- e\_irrad\_sd numeric (W m-2)

**Note**

Instrument used: Kipp SMP3 smart pyranometer, factory calibrated, mounted on tripod at approximately 2 m height. Data collected with a Campbell Scientific CR6 datalogger. Wavelength sensitivity range of the pyranometer is 300 nm to 2800 nm. Location: Viikki campus of the University of Helsinki. Coordinates: 60.226803 N, 25.019205 E.

**References**

<https://www.kippzonen.com/>

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ppfd_BF.data	<i>Ground level solar PAR photon irradiance, direct and diffuse (measured)</i>
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### Description

Dataset containing mean, maximum, minimum and standard deviation values for total, direct and diffuse photosynthetically active radiation expressed as photon irradiance. Each value is a summary 60 consecutive readings acquired once every second.

### Usage

ppfd\_BF.data

### Format

A data frame with 24479 rows and 9 variables. variables.

### Details

The variables are as follows:

- time\_EEST POSIXct Local time according to EET coordinates.
- ppfd\_tot\_mean numeric (mol m<sup>-2</sup> m<sup>-2</sup>)
- ppfd\_tot\_min numeric (mol m<sup>-2</sup> m<sup>-2</sup>)
- ppfd\_tot\_max numeric (mol m<sup>-2</sup> m<sup>-2</sup>)
- ppfd\_tot\_sd numeric (mol m<sup>-2</sup> m<sup>-2</sup>)
- ppfd\_diff\_mean numeric (mol m<sup>-2</sup> m<sup>-2</sup>)
- ppfd\_diff\_min numeric (mol m<sup>-2</sup> m<sup>-2</sup>)
- ppfd\_diff\_max numeric (mol m<sup>-2</sup> m<sup>-2</sup>)
- ppfd\_diff\_sd numeric (mol m<sup>-2</sup> m<sup>-2</sup>)

### Note

Instrument used: Delta-T BF5 "quantum sensor" , mounted on tripod at approximately 2 m height. Data collected with a Campbell Scientific CR6 datalogger, using analogue outputs from the sensor. Wavelength sensitivity range of the quantum sensor is 400 nm to 700 nm. Location: Viikki campus of the University of Helsinki. Coordinates: 60.226803 N, 25.019205 E.

### References

<https://www.delta-t.co.uk/>

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ppfd_LICOR.data	<i>Ground level solar PAR photon irradiance (measured)</i>
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### Description

Dataset containing mean, maximum, minimum and standard deviation values for photosynthetically active radiation expressed as photon irradiance. Each value is a summary 60 consecutive readings acquired once every second.

### Usage

ppfd\_LICOR.data

### Format

A data frame with 24479 rows and 5 variables.

### Details

The variables are as follows:

- time\_EEST POSIXct Local time according to EET coordinates.
- ppfd\_mean numeric (mol m<sup>-2</sup> m<sup>-2</sup>)
- ppfd\_min numeric (mol m<sup>-2</sup> m<sup>-2</sup>)
- ppfd\_max numeric (mol m<sup>-2</sup> m<sup>-2</sup>)
- ppfd\_sd numeric (mol m<sup>-2</sup> m<sup>-2</sup>)

### Note

Instrument used: LI-COR LI-190 quantum sensor, mounted on tripod at approximately 2 m height. Data collected with a Campbell Scientific CR6 datalogger. Sensor connected through a LI-COR millivolt adaptor (604 ohm). Wavelength sensitivity range of the quantum sensor is 400 nm to 700 nm. Location: Viikki campus of the University of Helsinki. Coordinates: 60.226803 N, 25.019205 E.

### References

<https://www.licor.com/>

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sun\_hourly\_august.spct

*Ground level spectral irradiance at hourly intervals*

---

## **Description**

Datasets containing the wavelengths at 1.0 nm interval and tabulated values spectral irradiance for the sun for 21 and 22 August in Helsinki, Finland.

## **Usage**

sun\_hourly\_august.spct

## **Format**

A data frame with 15841 rows (290 nm to 800 nm at 1 nm interval) and 3 variables.

## **Details**

The variables are as follows:

- w.length numeric (nm)
- s.e.irrad numeric (W m<sup>-2</sup> nm<sup>-1</sup>)
- UTC POSIXct (UTC date and time)

The data set includes NAs for missing night-time spectral irradiance values.

## **Note**

The simulation methods has been described in Lindfors et al. (2009).

## **Author(s)**

Anders K. Lindfors (radiation transfer modelling)

## **References**

Lindfors, A.; Heikkilä, A.; Kaurola, J.; Koskela, T. & Lakkala, K. (2009) Reconstruction of Solar Spectral Surface UV Irradiances Using Radiative Transfer Simulations. *Photochemistry and Photobiology*, 85: 1233-1239

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sun\_hourly\_june.spct *Ground level spectral irradiance at hourly intervals*

---

### Description

Datasets containing the wavelengths at 1.0 nm interval and tabulated values spectral irradiance for the sun for 22 to 24 June 2010 in Helsinki, Finland.

### Usage

sun\_hourly\_june.spct

### Format

A data frame with 29464 rows (293 nm to 800 nm at 1 nm interval) and 3 variables.

### Details

The variables are as follows:

- w.length numeric (nm)
- s.e.irrad numeric (W m<sup>-2</sup> nm<sup>-1</sup>)
- UTC POSIXct (UTC date and time)

The data set includes NAs for missing night-time spectral irradiance values.

### Note

A summary of these data has been published in the article by Morales et al. (2013). The simulation methods has been described in Lindfors et al. (2009).

### Author(s)

Anders K. Lindfors (radiation transfer modelling)

### References

- Morales, L. O.; Brosché, M.; Vainonen, J.; Jenkins, G. I.; Wargent, J. J.; Sipari, N.; Strid, A.; Lindfors, A. V.; Tegelberg, R. & Aphalo, P. J. (2013) Multiple roles for UV RESISTANCE LOCUS8 in regulating gene expression and metabolite accumulation in Arabidopsis under solar ultraviolet radiation. *Plant Physiology*, 161, 744-759
- Lindfors, A.; Heikkilä, A.; Kaurola, J.; Koskela, T. & Lakkala, K. (2009) Reconstruction of Solar Spectral Surface UV Irradiances Using Radiative Transfer Simulations. *Photochemistry and Photobiology*, 85: 1233-1239



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sun\_may\_morning.spct *Ground level solar spectral irradiance (measured)*

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## Description

Datasets containing the wavelengths at a 0.5 nm to 1.0 nm interval and tabulated values of measured spectral irradiance for the sun.

## Usage

sun\_may\_morning.spct

## Format

A data frame with 1425 rows (250 nm to 900 nm, variable step) and 3 variables.

## Details

The variables are as follows:

- w.length numeric (nm)
- s.e.irrad numeric ( $\text{W m}^{-2} \text{nm}^{-1}$ )

## Note

Instrument used: Maya2000Pro scanning double monochromator spectroradiometer with a Bentham cosine corrected input optics. Recently calibrated at STUK. Date and time: 31 May 2013, 11:23 EEST. Place: University of Helsinki, Viikki Campus, Finland. Coordinates: 60.226183 N, 25.018302 E. Measurements done by Pedro J. Aphalo. Calibration and corrections done with package MayaCalc using bracketing and noise reduction (with filter measurement) and method "sun". Algorithm and calibration data by Lasse Ylianttila (STUK, Helsinki, Finland).

## References

Ylianttila, L.; Visuri, R.; Huurto, L. & Jokela, K. (2005) Evaluation of a single-monochromator diode array spectroradiometer for sunbed UV-radiation measurements. *Photochem Photobiol*, 81, 333-341

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sun\_reference.mspct     *Reference solar spectra from ASTM G173*

---

### Description

Dataset containing wavelengths and tabulated values for spectral irradiance for the sun both above the terrestrial atmosphere and at ground level under clear sky. The different spectra in this collection are from ASTM G173 standard.

### Usage

sun\_reference.mspct

### Format

A "source\_mspct" object containing 51 "source\_spct" objects.

In each of the member spectra, the variables are as follows:

- w.length (nm)
- s.e.irrad ( $\text{W m}^{-2} \text{nm}^{-1}$ )

### Details

ASTM.E490.AM0 is the mean extraterrestrial solar spectrum, for air mass zero (AM0).

Gueymard.AM0 is Gueymard's (2004) extraterrestrial solar spectrum, for air mass zero (AM0). Used as the basis for calculating the terrestrial solar spectra defined by ASTM G173.

WMO.Wehrli.AM0 is Wehrli's (1985) extraterrestrial solar spectrum, for air mass zero (AM0). Used the World Meteorological Organization (WMO).

ASTM.G173.global is global spectral irradiance for air mass 1.5 (AM1.5). Reference Spectrum Derived from SMARTS v. 2.9.2 for AM1.5. (solar zenith angle 48.19)

ASTM.G173.direct is direct spectral irradiance for air mass 1.5 (AM1.5). Reference Spectrum Derived from SMARTS v. 2.9.2 for AM1.5. (solar zenith angle 48.19)

### Note

Please see the metadata in each spectrum. Metadata is stored in attributes and can accessed with functions [getWhatMeasured](#) and [comment](#).

### Source

<https://rredc.nrel.gov/solar/spectra/am1.5/>.

## **References**

ASTM (2012) ASTM G173 Standard Tables for Reference Solar Spectral Irradiances: Direct Normal and Hemispherical on 37 degrees Tilted Surface.

Gueymard, C. A. (2004) The sun's total and spectral irradiance for solar energy applications and solar radiation models. *Solar Energy*, 76, 423-453. <doi:10.1016/j.solener.2003.08.039>

Wehrli, C. (1985) Extraterrestrial solar spectrum. Pub. No. 615, World Radiation Center, Davos, Switzerland.

## **Examples**

```
names(sun_reference.mspct)
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