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```

R for Photobiology

A handbook

Pedro J. Aphalo,
Andreas Albert
and
Titta Kotilainen

Git: tag 'none', committed with hash 3fac7ba on 2015-07-07 10:00:02 +0300
by Pedro J. Aphalo
PDF created 7th July 2015

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Preface

This is just a very early draft of a handbook that will accompany the release of the suite of R packages for photobiology (`r4photobiology`).

Acknowledgements

We thank Stefano Catola, Paula Salonen, David Israel, Neha Rai, Tendry Randriamanana, Saara Harkikainen, Christian Bianchi-Strømme and ... for very useful comments and suggestions. We specially thank Matt Robson for exercising the packages with huge amounts of spectral data and giving detailed feedback on problems, and in particular for describing needs and proposing new features.

List of abbreviations and symbols

For quantities and units used in photobiology we follow, as much as possible, the recommendations of the Commission Internationale de l'Éclairage as described by (Slaney2007).

Symbol	Definition
α	(%).
Δe	water vapour pressure difference (Pa).
ϵ	emittance (W m^{-2}).
λ	wavelength (nm).
θ	solar zenith angle (degrees).
ν	frequency (Hz or s^{-1}).
ρ	(%).
σ	Stefan-Boltzmann constant.
τ	(%).
χ	water vapour content in the air (g m^{-3}).
A	(absorbance units).
ANCOVA	analysis of covariance.
ANOVA	analysis of variance.
BSWF	.
c	speed of light in a vacuum.
CCD	charge coupled device, a type of light detector.
CDOM	coloured dissolved organic matter.
CFC	chlorofluorocarbons.
c.i.	confidence interval.
CIE	Commission Internationale de l'Éclairage; or erythema action spectrum standardized by CIE.
CTC	closed-top chamber.
DAD	diode array detector, linear light detector based on photodiodes.
DBP	dibutylphthalate.
DC	direct current.
DIBP	diisobutylphthalate.
DNA(N)	UV action spectrum for 'naked' DNA.
DNA(P)	UV action spectrum for DNA in plants.
DOM	dissolved organic matter.
DU	Dobson units.
e	water vapour partial pressure (Pa).
E	(energy) irradiance (W m^{-2}).
$E(\lambda)$	spectral (energy) irradiance ($\text{W m}^{-2} \text{ nm}^{-1}$).

LIST OF ABBREVIATIONS AND SYMBOLS

E_0	fluence rate, also called scalar irradiance (W m^{-2}).
ESR	early stage researcher.
FACE	free air carbon-dioxide enhancement.
FEL	a certain type of 1000 W incandescent lamp.
FLAV	UV action spectrum for accumulation of flavonoids.
FWHM	full-width half-maximum.
GAW	Global Atmosphere Watch.
GEN	generalized plant action spectrum, also abbreviated as GPAS (Caldwell1971).
GEN(G)	mathematical formulation of GEN by (Green1974) .
GEN(T)	mathematical formulation of GEN by (Thimijan1978).
h	Planck's constant.
h'	Planck's constant per mole of photons.
H	exposure, frequently called dose by biologists ($\text{kJ m}^{-2} \text{d}^{-1}$).
H^{BE}	biologically effective (energy) exposure ($\text{kJ m}^{-2} \text{d}^{-1}$).
H_p^{BE}	biologically effective photon exposure ($\text{mol m}^{-2} \text{d}^{-1}$).
HPS	high pressure sodium, a type of discharge lamp.
HSD	honestly significant difference.
k_B	Boltzmann constant.
L	radiance ($\text{W sr}^{-1} \text{m}^{-2}$).
LAI	leaf area index, the ratio of projected leaf area to the ground area.
LED	light emitting diode.
LME	linear mixed effects (type of statistical model).
LSD	least significant difference.
n	number of replicates (number of experimental units per treatment).
N	total number of experimental units in an experiment.
N_A	Avogadro constant (also called Avogadro's number).
NIST	National Institute of Standards and Technology (U.S.A.).
NLME	non-linear mixed effects (statistical model).
OTC	open-top chamber.
PAR	, 400–700 nm. measured as energy or photon irradiance.
PC	polycarbonate, a plastic.
PG	UV action spectrum for plant growth.
PHIN	UV action spectrum for photoinhibition of isolated chloroplasts.
PID	(control algorithm).
PMMA	polymethylmethacrylate.
PPFD	, another name for PAR photon irradiance (Q_{PAR}).
PTFE	polytetrafluoroethylene.
PVC	polyvinylchloride.
q	energy in one photon ('energy of light').
q'	energy in one mole of photons.
Q	photon irradiance ($\text{mol m}^{-2} \text{s}^{-1}$ or $\mu\text{mol m}^{-2} \text{s}^{-1}$).
$Q(\lambda)$	spectral photon irradiance ($\text{mol m}^{-2} \text{s}^{-1} \text{nm}^{-1}$ or $\mu\text{mol m}^{-2} \text{s}^{-1} \text{nm}^{-1}$).
r_0	distance from sun to earth.
RAF	(nondimensional).
RH	relative humidity (%).
s	energy effectiveness (relative units).

$s(\lambda)$	spectral energy effectiveness (relative units).
s^p	quantum effectiveness (relative units).
$s^p(\lambda)$	spectral quantum effectiveness (relative units).
s.d.	standard deviation.
SDK	software development kit.
s.e.	standard error of the mean.
SR	spectroradiometer.
t	time.
T	temperature.
TUV	tropospheric UV.
U	electric potential difference or voltage (e.g. sensor output in V).
UV	ultraviolet radiation ($\lambda = 100\text{--}400\text{ nm}$).
UV-A	ultraviolet-A radiation ($\lambda = 315\text{--}400\text{ nm}$).
UV-B	ultraviolet-B radiation ($\lambda = 280\text{--}315\text{ nm}$).
UV-C	ultraviolet-C radiation ($\lambda = 100\text{--}280\text{ nm}$).
UV ^{BE}	biologically effective UV radiation.
UTC	coordinated universal time, replaces GMT in technical use.
VIS	radiation visible to the human eye ($\approx 400\text{--}700\text{ nm}$).
WMO	World Meteorological Organization.
VPD	water vapour pressure deficit (Pa).
WOUDC	World Ozone and Ultraviolet Radiation Data Centre.

Part I

Theory behind calculations

