Package 'CanopyPhotosynthesis'

May 24, 2016

Type Package

Title Canopy photosynthesis testbed

Version 1.0

Date 2016-05-04

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Description Testbed for canopy scaling and modeling of Photosynthesis and GPP

Depends XML

Suggests testthat

SystemRequirements

OS_type Windows, unix, mac

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LazyLoad yes

LazyData FALSE

RoxygenNote 5.0.1

R topics documented:

Func_Canopy_Radiation_Transfer
Func_Canopy_Radiation_Transfer

Description

Function for revised DF1997 model to partition canopy LAI into sunlit/shade leaves LAI and partition canopy Vcmax into sunlit/shade leaves Vcmax clumping index was added to original DF1997 model, following the reference from Ryu et al. 2011

Usage

```
Func_Canopy_Radiation_Transfer(FLAG, SZA, LAI, Ib0, Id0, Vcmax0_25, CI)
```

Arguments

FLAG	Model version controller; 0–Lloyd et al. 2010 Model for Vcmax-LAI relationship; 1–Mercado et al. 2006 Model for Vcmax-LAI relationship in the tropics
SZA	solar zenith angle, in degrees
LAI	Canopy leaf area index
Ib0	direct beam at canopy top
Id0	diffuse irradiance at canopy top
Vcmax0_25	Vcmax at reference 25 degrees C for top-of-canopy leaves
CI	Clumping inedx; 0.63 for tropical evergreen forests (Chen et al, 2005)

Details

Goal: Use revised DF1997 model to partition canopy LAI into sunlit/shade leaves LAI and partition canopy Vcmax into sunlit/shade leaves Vcmax clumping index was added to original DF1997 model, following the reference from Ryu et al. 2011

Value

List containing: PAR0 - ; Ib0 - ; Id0 - ; Lsun - Sunlit LAI; Lshade - Shade LAI; Ic - Canopy total absorbed irradiance; Isun - Sunlit leaf absorbed irradiance; Ishade - Shade leaf absorbed irradiance; Vc - Canopy total Vcmax; Vcsun - Sunlit leaf Vcmax; Vcshade - Shade leaf Vcmax

Author(s)

Jin Wu

Shawn Serbin

References

dePury and Farquhar, 1997; Ryu et al., 2011

Examples

```
FLAG <- 1
SZA <- 30
LAI <- 6
Press <- 10^5
PAR0 <- 1320 # top canop irradiance, in umol/m2/s
Vcmax0_25 <- 40 # Bonan et al., 2012 for the tropcis
Clumping <- 0.63 # Clumping index, from Chen etal., 2005 for tropical evergreen forests

LQ <- Func_Light_Partitioning(SZA=SZA,P=Press,PAR=PAR0)
Ib0 <- LQ$Model_DV
Id0 <- LQ$Model_dV

output <- Func_Canopy_Radiation_Transfer(FLAG=FLAG, SZA=SZA, LAI=LAI, Ib0=Ib0, Id0=Id0, Vcmax0_25=Vcmax0_25,
```

`Func_Leaf_FvCB_Photosynthesis_Model`

Func_Leaf_FvCB_Photosynthesis_Model

Description

Leaf level FvCB Photosynthesis model (Farquhar et al. 1980)

Usage

```
Func_Leaf_FvCB_Photosynthesis_Model(Vcmax25, Jmax25, Tleaf, Topt, I, Ci, Press,
  PSII_in, Phi_in)
```

Arguments

`Vcmax25`	Vcmax at 25 degrees C
`Jmax25`	Jmax at 25 degrees C
`Tleaf`	Leaf temperature in degrees C
`Topt`	Temperature optimum for Jmax
`I`	incident light
`Ci`	internal CO2 concentration in umols/mol or ppm
`Press`	Atmospheric pressure in Pa
`PSII_in`	Input PSII for maximum quantum yield
`Phi_in`	Input curvature factor for light response function

Value

List containing: Anet - Net photosynthetic rate (Agross-Rd,umol/m2/s) at leaf temperature, Agross - Gross photosynthetic rate (umol/m2/s) at leaf temperature, Rd - Leaf respiration rate (umol/m2/s) at leaf temperature, Wc - Rubisco limited photosynthetic rate (umol/m2/s), Wj - RuBP limited photosynthetic rate (umol/m2/s), Wp - TPU limited photosynthetic rate (0.5*Vcmax, umol/m2/s), Vcmax - Maximum rate of RuBP carboxylation (umol/m2/s) at leaf temperature, Jmax - Maximum rate of electron transport (umol/m2/s) at leaf temperature, Vo - , Vomax - Maximum rate of oxygen evolution (umol/m2/s) at leaf temperature, Gamma* - at leaf temperature, Kc - , Ko - , PSII - , Phi - at leaf temperature

Author(s)

Jin Wu

Shawn Serbin

References

Long and Bernacchi, 2003; Medlyn et al., 2002; Bernacchi et al., 2013

Examples

```
## Not run:
# Run test leaf photosynthesis simulations
file <- system.file('examples/Example_Leaf_Photosynthesis.R',package='CanopyPhotosynthesis')
source(file)


## End(Not run)
```

`Func_Light_Partitioning` *Func_Light_Partitioning*

Description

Function to partitioning incident radiatoin into direct and diffuse radiation, based on the Weiss and Norman, 1985 light partitioning approach

Usage

```
Func_Light_Partitioning(SZA, P, PAR)
```

Arguments

SZA	solar zenith angle, in degrees
P	Atmospheric Pressure, in pa
PAR	measured total PAR? umol/m2/s

Details

Weiss and Norman, 1985 light partitioning approach

Value

List containing: SZA - solar zenith angle, PAR - PAR, SV - total Visible light, SN - total NIR light, Ratio - the ratio between total measured light and total modeled light, fV - fraction of visble direct beam, fN - fraction of NIR direct beam, Model_DV - direct visible light, Model_dV - diffuse visible light, Model_DN - direct NIR light, Model_dN - diffuse NIR light

Author(s)

Jin Wu

Shawn Serbin

References

Weiss and Norman, 1985

`Func_Multi_Layer_Photosynthesis_Model`
Func_Multi_Layer_Photosynthesis_Model

Description

Canopy multi-layer photosynthesis model

Usage

```
Func_Multi_Layer_Photosynthesis_Model(FLAG, SZA, Press, PAR0, LAI, Tleaf,
  Tleaf_diff, ambCO2, Vcmax0_25, CI, Topt, Nlayers, Phi_sun, PSII_sun,
  Phi_shade, PSII_shade, sf_sun, sf_shade, sf)
```

Arguments

FLAG	Model version controller; 0–Lloyd et al. 2010 Model for Vcmax-LAI relationship; 1–Mercado et al. 2006 Model for Vcmax-LAI relationship in the tropics
SZA	solar zenith angle, in degrees
Press	Atmospheric pressure in Pa
PAR0	measured top canop irradiance, in umol/m2/s
LAI	total canopy LAI
Tleaf	Leaf temperature in degrees C
Tleaf_diff	Difference in leaf temperature between sunlit and shaded leaf fractions in degrees C
ambCO2	ambient CO2 concentration, in ppm
Vcmax0_25	Vcmax at reference 25 degrees C for top-of-canopy leaves
CI	Clumping inedx; 0.63 for tropical evergreen forests (Chen et al, 2005)
Topt	optimal leaf temperature for tropical evergreen forests, from Lloyd and Farquhar, 2008
Nlayers	number of layers for Multi-Layer Photosynthesis Modeling
Phi_sun	the curvature factor for light response curves for sunlit leaves
PSII_sun	maximum quantum yield for sunlit leaves
Phi_shade	the curvature factor for light response curves for sunlit leaves
PSII_shade	maximum quantum yield for shade leaves
sf_sun	scaling factor for sunlit leaves, due to leaf age effect
sf_shade	scaling factor for shade leaves, due to leaf age effect
sf	scaling factor due to leaf age effect, assuming no phenological partitioning across vertical canopy profile

Author(s)

Jin Wu

Shawn Serbin

`Func_Temperature_Bernacchi`
Func_Temperature_Bernacchi

Description

Bernacchi temperature response function for photosynthesis parameters

Usage

```
Func_Temperature_Bernacchi(delta_H, c, Tleaf)
```

Arguments

`delta_H`	Activation energy
`c`	Scaling constant
`Tleaf`	leaf temperature in degrees C

Details

Bernacchi temperature response function for photosynthesis parameters

Value

temperature scale factor

Author(s)

Jin Wu

Shawn Serbin

References

Bernacchi et al., 2002

Func_Temperature_June *Func_Temperature_June*

Description

June temperature response function for photosynthesis parameters

Usage

```
Func_Temperature_June(P25, Topt, Tleaf)
```

Arguments

P25	Vcmax/Jmax at 25 degrees C
Topt	Temperature optimum of Vcmax/Jmax
Tleaf	leaf temperature in degrees C

Details

June temperature response function for photosynthesis parameters

Author(s)

Jin Wu

Shawn Serbin

References

Bernacchi et al. 2013 and June et al. 2004

Func_Temperature_Medlyn *Func_Temperature_Medlyn*

Description

Medlyn Arrhenius function

Usage

```
Func_Temperature_Medlyn(Tleaf.1, Tleaf.2, Param, Ea)
```

Arguments

Tleaf.1	Original leaf temperature (degrees C)
Tleaf.2	Leaf temperature to scale parameter to (degrees C)
Param	Parameter (e.g. Vcmax, Kc, Gamma*) value at Tleaf.1
Ea	Activation energy for Arrehnius function. Dependent on parameter of interest

Details

Medlyn Arrhenius temperature response function for photosynthesis parameters, based on Bernacchi et al. 2002. Used for Vcmax, Jmax, Rd, Kc, Ko, Gamma*

Value

Parameter scaled to Tleaf.2 following the Arrhenius function in Medlyn et al., 2002

Author(s)

Jin Wu

Shawn Serbin

References

Bernacchi et al., 2002; 2003; Medlyn et al., 2002

`Func_Temperature_Response`
Func_Temperature_Response

Description

Temperature response functions for scaling leaf-level photosynthesis parameters

Usage

```
Func_Temperature_Response(V25, J25, Tleaf, Topt, Press)
```

Arguments

`J25`	Jmax at 25 degrees C
`Tleaf`	leaf temperature in degrees C
`Topt`	Temperature optimum of Vcmax/Jmax
`Press`	Atmospheric pressure in Pa
`VC25`	Vcmax at 25 degrees C

Details

Temperature response functions for scaling leaf-level photosynthesis parameters

Value

List containing: Vcmax - Vcmax at leaf temperature, Jmax - Jmax at leaf temperature, Gamma_star - Gamma* at leaf temperature, Kc - Kc MM constant at leaf temperature, Ko - Ko MM constant at leaf temperature, PSII - PSII at leaf temperature, Phi - Phi at leaf temperature, Rd - leaf respiration at leaf temperature, Vomax - Vomax (max oxygen evolution) at leaf temperature

Author(s)

Jin Wu

Shawn Serbin

References

Bernacchi et al., 2002, 2003, 2013

`model.options` *parse model.options.xml file used to set parameters and other options for model runs*

Description

Read model.options.xml file

Usage

```
model.options(input.file = NULL)
```

Arguments

`input.file`	model.options.xml file containing information needed for run

Author(s)

Jin Wu, Shawn P. Serbin

Examples

```
## Not run:
opt <- model.options()
model.options <- model.options('/home/$USER/model.options.xml')

## End(Not run)
```

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