Leaf Gas Exchange Calculator

Version 1.0
2/3/2015 1:23:00 PM

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Photosynthesis Module

Introduction

This is a C++ module to simulate gas exchange processes in a leaf. The Gas Exchange class encapsulates all the calculations to estimate photsynthetic rate, CO2 assimilation, stomatal conductance, and transpiration for a square meter of leaf.

This is a coupled model of photosynthesis-stomatal conductance-energy balance for a maize leaf
this unit simulates Maize leaf gas-exchange characteristics including photosynthesis,
traspiration, boundary and stomatal conductances, and leaf temperature based
on von Caemmerer (2000) C4 model, BWB stomatal conductance (1987) and
Energy balance model as described in Campbell and Norman (1998)

Authors:

Soo-Hyung Kim, Univ of Washington
Dennis Timlin, USDA-ARS, Beltsville, MD
David Fleisher, USDA-ARS, Beltsville, MD

Version:

1.0

Date:

January 2015

Bibliography

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- Kim, S.-H., R.C. Sicher, H. Bae, D.C. Gitz, J.T. Baker, D.J. Timlin, and V.R. Reddy. 2006. Canopy photosynthesis, evapotranspiration, leaf nitrogen, and transcription
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Source Code

```
Source Code is available on GITHUB
```

Namespace Index

Namespace List

Here is a list of all namespaces with brief descriptions:

Class Index

Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

File Index

File List

Here is a list of all files with brief descriptions:

Namespace Documentation

photomod Namespace Reference

Photosynthesis Model NameSpace.

Classes

- class **CGasExchange**

Functions

- double **Min** (double a, double b, double c)
- double **Square** (double a)

Detailed Description

Photosynthesis Model NameSpace.

Function Documentation

double photomod::Min (double *a*, double *b*, double *c*) `[inline]`

Definition at line 37 of file gas_exchange.cpp.

double photomod::Square (double *a*) `[inline]`

Definition at line 36 of file gas_exchange.cpp.

Class Documentation

_tmain Class Reference

Detailed Description

interface to photosynthesis module

This program demonstrates how to call the photosynthesis module Photosynthesis(notManaged).cpp : Defines the entry point for the console application.

Use of this interface

Two files are needed:

1. a parameter file containing the parameters for the photosynthesis module, one line for each species
2. an environmental file with temperature, radiation, CO2 content, humidity, wind and a flag (0,1) to tell the program if constant temperature is used (or let temperature of leaf vary with stomatal conductance.

The documentation for this class was generated from the following file:

- **Photosynthesis(notManaged).cpp**

photomod::CGasExchange Class Reference

`#include <gas_exchange.h>`

Classes

- struct **tParms**

tParms ***Structure to hold parameters for the model*** Public Member Functions

- **CGasExchange** ()
  This is the constructor.
- double **get_AGross** ()
- double **get_ANet** ()
- double **get_BoundaryLayerConductance** ()
- double **get_Ci** ()
- double **get_LeafTemperature** ()
- double **get_Respiration** ()
- double **get_StomatalConductance** ()
- double **get_Transpiration** ()
- double **get_VPD** ()
- void **SetParams** (**tParms** ***sParms**)
  used to pass structure with parameters from the main program
- void **SetVal** (double **PhotoFluxDensity**, double **Tair**, double **CO2**, double **RH**, double **wind**, double **Press**, bool ConstantTemperature)
  sets input values for calculations for a particular set of environmental variables
- **~CGasExchange** (void)
  This is the destructor.

Public Attributes

- struct **photomod::CGasExchange::tParms sParms**

Protected Member Functions

- double **CalcStomatalConductance** ()
  returns stomatal conductance (mol m-2 s-1)
- double **CalcTurbulentVaporConductance** ()
  returns conductance for turbulant vapor transfer in air - forced convection (mol m-2 s-1)
- void **EnergyBalance** ()
  calculates leaf temperature and transpiration
- double **Es** (double Temperature)
  returns saturated vapor pressure at temperature (T). kPa
- double **EvalCi** (double **Ci**)
  Calls photosynthesis modules to evaluate Ci dependent calculations returns internal CO2 concentration.
- void **GasEx** ()
  Main module to calculate gas exchange rates.
- double **get_CiCaRatio** ()
  returns ratio between internal and atmospheric CO2
- double **minh** (double fn1, double fn2, double theta2)

returns hyperbolic minimum

- void **PhotosynthesisC3** (double **Ci**)
  C3 photosynthesis module.
- void **PhotosynthesisC4** (double **Ci**)
  C4 photosynthesis module.
- double **QuadSolnLower** (double a, double b, double c)
  returns lower part of quadratic equation solution
- double **QuadSolnUpper** (double a, double b, double c)
  returns upper part of quadratic equation solution
- double **SearchCi** (double CO2i)
  called iterively to find optimal internal CO2 concentration returns optimal internal CO2 concentration (CO2i)
- double **Slope** (double Temperature)
  returns slope of the vapor pressure curve

Protected Attributes

- double **age**
  leaf age (days)(not used now)
- double **AssimilationGross**
  gross photosynthesis (umol CO2 m-2 s-1) (Adjusted for respiration)
- double **AssimilationNet**
  These variables hold the output of calculations.
- double **BoundaryLayerConductance**
  boundary layer conductance umol m-2 s-1
- double **Ci**
  Internal CO2 concentration umol mol-1.
- double **Ci_Ca**
  ratio of internal to external CO2, unitless
- double **CO2**
  CO2 concentration (umol mol-1 air)
- bool **ConstantLeafTemperature**
  *if true, uses constant temperature - if true, does not solve for leaf temperature */*
- double **DarkRespiration**
  plant respiration umol m-2 s-1
- double **eqlTolerance**
- double **errTolerance**
- bool **isCiConverged**
- int **iter1**
- int **iter2**
  holds iteration counters
- int **iter_Ci**
- int **iter_total**
- double **PhotoFluxDensity**
  Photosynthetic Flux Density (umol photons m-2 s-1.
- *std::string **PlantType**
  *For C3 or C4 designation */.*
- double **Press**

Air pressure (kPa)

- double **R_abs**
  absorbed incident radiation (watts m-2)
- double **RH**
  Relative Humidity (%, i.e., 80)
- double **StomatalConductance**
  stomatal conductance umol m-2 s-1
- double **Tair**
  Air temperature at 2m, (C)
- double **Tleaf**
  Leaf temperature C.
- double **Transpiration**
  transpiration mol h2o m-2 s-1
- double **VPD**
  *Vapor Pressure Density, kPa */.*
- double **width**
  Leaf width (m)
- double **wind**
  Windspeed at 2 meters (km s-1)

Detailed Description

Class for gas exchange calculations

This class simulates gas exchange in plant leaves. Photosynthetic parameters were calibrated with Maize hybrid PI3733 from SPAR experiments at Beltsville, MD in 2002 (see Bibliography).

Stomatal conductance parameters were not calibrated

Use **SetParams** to initialize with parameters for a specific variety of plant

Use **SetVal** to pass environmental variables and return a structure with output.

Definition at line 55 of file gas_exchange.h.

Constructor & Destructor Documentation

photomod::CGasExchange::CGasExchange ()

This is the constructor.

Constructor - Some initialization is done here.

Definition at line 41 of file gas_exchange.cpp.

photomod::CGasExchange::~CGasExchange (void)

This is the destructor.

Destructor - nothing is done here

Definition at line 57 of file gas_exchange.cpp.

Member Function Documentation

double photomod::CGasExchange::CalcStomatalConductance () [protected]

returns stomatal conductance (mol m-2 s-1)

calculates and returns stomatal conductance for water vapor in mol m-2 s-1 Uses Ball-Berry model.

See also:

Es()

Returns:

stomatal conductance for water vapor

Ds, VPD at leaf surface

aa, a value in quadratic equation

bb, b value in quadratic equation

cc, calcuation variable (x) in quadratic equation

hs, solution for relative humidity

Cs, estimate of mole fraction of CO2 at the leaf surface

Gamma, CO2 compensation point in the absence of mitochondirial respiration, in ubar

StomatalConductance, temporary variable to hold stomatal conductance

Definition at line 395 of file gas_exchange.cpp.

double photomod::CGasExchange::CalcTurbulentVaporConductance (void) [protected]

returns conductance for turbulant vapor transfer in air - forced convection (mol m-2 s-1)

calculates and returns conductance for turbulant vapor transfer in air - forced convection units are mol m-2 s-1

Returns:

conductance for turbulent vapor transfer in air

Definition at line 437 of file gas_exchange.cpp.

void photomod::CGasExchange::EnergyBalance () [protected]

calculates leaf temperature and transpiration

Calculates Transpiration rate (T) and leaf temperature (Tleaf). Iterates by recalculating photosynthesis until leaf temperatures converge

See Campbell and Norman (1998) pp 224-225

Does not have input

Returns:

nothing but calculates transpiration (T) and leaf temperature (Tleaf)

Because Stefan-Boltzman constant is for unit surface area by denifition, all terms including sbc are multilplied by 2 (i.e., RadiativeConductance, thermal radiation)

Definition at line 328 of file gas_exchange.cpp.

double photomod::CGasExchange::Es (double *Temperature*) [protected]

returns saturated vapor pressure at temperature (T). kPa

calculates and returns Saturation vapor pressure (kPa)

Parameters:

in	*Temperature*	

Returns:

saturated vapor pressure

Definition at line 455 of file gas_exchange.cpp.

double photomod::CGasExchange::EvalCi (double *Ci*) [protected]

Calls photosynthesis modules to evaluate Ci dependent calculations returns internal CO2 concentration.

calculates a new value of Ci for the current values of photosynthesis and stomatal conductance determined using parameters from a previous step where the energy balance was solved

Parameters:

in	*Ci*	**, internal CO2 concentration, umol mol-1

Returns:

the difference between the passed value and the new one.

Definition at line 561 of file gas_exchange.cpp.

void photomod::CGasExchange::GasEx (void) [protected]

Main module to calculate gas exchange rates.

carries out calculations for photosynthesis and stomatal conductance. no parameters, returns nothing

See also:

SearchCi(),
EnergyBalance(),
CalcStomatalConductance()

Returns:

nothing

Definition at line 149 of file gas_exchange.cpp.

double photomod::CGasExchange::get_AGross () [inline]

Returns:
gross photosynthesis (umol CO2 m-2 s-1)
Definition at line 131 of file gas_exchange.h.

double photomod::CGasExchange::get_ANet () [inline]

Returns:
net photosynthesis (umol CO2 m-2 s-1)
Definition at line 130 of file gas_exchange.h.

double photomod::CGasExchange::get_BoundaryLayerConductance () [inline]

Returns:
boundary layer conductance (mol m-2 s-1)
Definition at line 136 of file gas_exchange.h.

double photomod::CGasExchange::get_Ci () [inline]

Returns:
internal CO2 concentration (umol mol-1)
Definition at line 134 of file gas_exchange.h.

double photomod::CGasExchange::get_CiCaRatio () [inline], [protected]

returns ratio between internal and atmospheric CO2
Definition at line 187 of file gas_exchange.h.

double photomod::CGasExchange::get_LeafTemperature () [inline]

Returns:
leaf temperature (C)
Definition at line 133 of file gas_exchange.h.

double photomod::CGasExchange::get_Respiration () [inline]

Returns:
respiration rate (umol CO2 m-2 s-1)
Definition at line 137 of file gas_exchange.h.

double photomod::CGasExchange::get_StomatalConductance () [inline]

Returns:

stomatal conductance to water vapor (mol m-2 s-1)

Definition at line 135 of file gas_exchange.h.

double photomod::CGasExchange::get_Transpiration () [inline]

Returns:

transpiration rate (umol H2O m-2 s-1)

Definition at line 132 of file gas_exchange.h.

double photomod::CGasExchange::get_VPD () [inline]

Returns:

vapor pressure deficit (kpa)

Definition at line 129 of file gas_exchange.h.

double photomod::CGasExchange::minh (double *fn1*, double *fn2*, double *theta2*) [protected]

returns hyperbolic minimum

Parameters:

in	*fn1*	first value to be compared for min
in	*fn2*	second value to be compared for min
in	*theta2*	curvature factor

Returns:

hyperbolic minimum

Definition at line 615 of file gas_exchange.cpp.

void photomod::CGasExchange::PhotosynthesisC3 (double *Ci*) [protected]

C3 photosynthesis module.

Calculates photosynthesis for C3 plants

Uses as input incident PhotoFluxDensity, Air temp in C, CO2 in ppm, RH in per percent.

See also:

SetVal()

Parameters:

in	*Ci*	- internal CO2 concentration, umol mol-1

Returns:

nothing.

< Curvature -factor of Av and Aj colimitation

< Kc25, MM Constant of rubisco for CO2 of C3 plants (de Pury and Farquar, 1997) (umol m-2 s-1)

< Ko25, MM Constant of rubiscuo for O2 from above reference (umol m-2 s-1)

< Eac, Energy Activation kJ mol-1

< Eao, activation energy values

Definition at line 176 of file gas_exchange.cpp.

void photomod::CGasExchange::PhotosynthesisC4 (double *Ci*) [protected]

C4 photosynthesis module.

Calculates photosynthesis for C4 plants. Requires Incident PhotoFluxDensity, Air temp in C, CO2 in ppm, RH in percent

See also:

SetVal()

Parameters:

in	*Ci*	- internal CO2 concentration, umol mol-1

Returns:

nothing

<curvature factor of Av and Aj colimitation

< Kc25, Michaelis constant of rubisco for CO2 of C4 plants (2.5 times that of tobacco), ubar, Von Caemmerer 2000

< Ko25, Michaelis constant of rubisco for O2 (2.5 times C3), mbar

< Kp25, Michaelis constant for PEP caboxylase for CO2 - was 60 in Soo's paper

< EAO, activation energy for Ko

< Vpr25, PEP regeneration limited Vp at 25C, value adopted from vC book

< gbs, bundle sheath conductance to CO2, umol m-2 s-1 gbs x Cm is the inward diffusion of CO2 into the bundle sheath

< x, Partitioning factor of J, yield maximal J at this value

< alpha, fraction of PSII activity in the bundle sheath cell, very low for NADP-ME types

< gi, conductance to CO2 from intercelluar to mesophyle, mol m-2 s-1, assumed was 1, changed to 5 as per Soo 6/2012

< beta, smoothing factor

< gamma1, half the reciprocal of rubisco specificity, to account for O2 dependence of CO2 comp point, note that this become the same as that in C3 model when multiplied by [O2]

<Kp, Kc, Ko, Km, Calculated Michaelis params as a function of temperature

Definition at line 241 of file gas_exchange.cpp.

double photomod::CGasExchange::QuadSolnLower (double *a*, double *b*, double *c*) [protected]

returns lower part of quadratic equation solution

solves the lower part of the quadratic equation ax2+bx=c

Parameters:

in	*a*	
in	*b*	
in	*c*	

Returns:

lower portion of x

Definition at line 600 of file gas_exchange.cpp.

double photomod::CGasExchange::QuadSolnUpper (double *a*, double *b*, double *c*) [protected]

returns upper part of quadratic equation solution

solves the uppper part of the quadratic equation ax2+bx2=c

Parameters:

in	*a*	
in	*b*	
in	*c*	

Returns:

lower portion of x

Definition at line 585 of file gas_exchange.cpp.

double photomod::CGasExchange::SearchCi (double *CO2i*) [protected]

called iterively to find optimal internal CO2 concentration returns optimal internal CO2 concentration (CO2i)

does a secant search to find the optimal internal CO2 concentration (ci Calls:

See also:

EvalCi()

Parameters:

in	*CO2i*	- internal CO2 concentration, umol mol-1

Returns:

Ci

Definition at line 488 of file gas_exchange.cpp.

void photomod::CGasExchange::SetParams (tParms * *sParms*)

used to pass structure with parameters from the main program

See also:

SetParams for definitions

Definition at line 63 of file gas_exchange.cpp.

void photomod::CGasExchange::SetVal (double *PhotoFluxDensity*, double *Tair*, double *CO2*, double *RH*, double *wind*, double *Press*, bool *ConstantTemperature*)

sets input values for calculations for a particular set of environmental variables

Parameters:

tParms	- a structure to hold input parameters for the variety

Sets environment variables for a single execution of the module / Calls **GasEx()** to calculate photosynthetic rate and stomatal conductance.

Parameters:

in	*PhotoFluxDensity*	Photosynthetic Flux Density (umol Quanta m-2 s-1) (check)
in	*Tair*	Air Temperature (C)
in	*CO2*	CO2 concentration of the air (umol mol-1)
in	*RH*	Relative Humidity (%)
in	*wind*	Windspeed at 2.5 m, m s-1
in	*Press*	Atmospheric pressure (kpa m-2)
in	*ConstantTemperature*	boolian if true, leaf temperature=air temperature when calculating gas exchange

Returns:

nothing

Definition at line 118 of file gas_exchange.cpp.

double photomod::CGasExchange::Slope (double *Temperature*) [protected]

returns slope of the vapor pressure curve

Calculates and returns the slope of the sat vapor pressure curve: first order derivative of Es with respect to T

Parameters:

in	*Temperature*	(C)

See also:

Es()

Returns:

slope of the vapor pressure curve kPa T-1 (?)

Definition at line 470 of file gas_exchange.cpp.

Member Data Documentation

double photomod::CGasExchange::age [protected]

leaf age (days)(not used now)

Definition at line 141 of file gas_exchange.h.

double photomod::CGasExchange::AssimilationGross [protected]

gross photosynthesis (umol CO2 m-2 s-1) (Adjusted for respiration)
Definition at line 153 of file gas_exchange.h.

double photomod::CGasExchange::AssimilationNet [protected]

These variables hold the output of calculations.
net photosynthesis (umol CO2 m-2 s-1)
Definition at line 153 of file gas_exchange.h.

double photomod::CGasExchange::BoundaryLayerConductance [protected]

boundary layer conductance umol m-2 s-1
Definition at line 153 of file gas_exchange.h.

double photomod::CGasExchange::Ci [protected]

Internal CO2 concentration umol mol-1.
Definition at line 153 of file gas_exchange.h.

double photomod::CGasExchange::Ci_Ca [protected]

ratio of internal to external CO2, unitless
Definition at line 153 of file gas_exchange.h.

double photomod::CGasExchange::CO2 [protected]

CO2 concentration (umol mol-1 air)
Definition at line 141 of file gas_exchange.h.

bool photomod::CGasExchange::ConstantLeafTemperature [protected]

if true, uses constant temperature - if true, does not solve for leaf temperature */
Definition at line 170 of file gas_exchange.h.

double photomod::CGasExchange::DarkRespiration [protected]

plant respiration umol m-2 s-1
Definition at line 153 of file gas_exchange.h.

double photomod::CGasExchange::eqlTolerance [protected]

equality tolerance
Definition at line 164 of file gas_exchange.h.

double photomod::CGasExchange::errTolerance [protected]

error tolerance for iterations

Definition at line 163 of file gas_exchange.h.

bool photomod::CGasExchange::isCiConverged [protected]

true if Ci (internal CO2 concentration) iterations have converged

Definition at line 190 of file gas_exchange.h.

int photomod::CGasExchange::iter1 [protected]

Definition at line 188 of file gas_exchange.h.

int photomod::CGasExchange::iter2 [protected]

holds iteration counters

Definition at line 188 of file gas_exchange.h.

int photomod::CGasExchange::iter_Ci [protected]

iteration value for Ci umol mol-1, internal CO2 concentration

Definition at line 189 of file gas_exchange.h.

int photomod::CGasExchange::iter_total [protected]

holds total number of iterations

Definition at line 166 of file gas_exchange.h.

double photomod::CGasExchange::PhotoFluxDensity [protected]

Photosynthetic Flux Density (umol photons m-2 s-1.

Definition at line 141 of file gas_exchange.h.

*** std::string photomod::CGasExchange::PlantType [protected]**

For C3 or C4 designation */.

Parameters:

PlantType	string that holds the type of plant, C3 or C4

Definition at line 169 of file gas_exchange.h.

double photomod::CGasExchange::Press [protected]

Air pressure (kPa)

Definition at line 141 of file gas_exchange.h.

double photomod::CGasExchange::R_abs [protected]

absorbed incident radiation (watts m-2)
Definition at line 141 of file gas_exchange.h.

double photomod::CGasExchange::RH [protected]

Relative Humidity (%, i.e., 80)
Definition at line 141 of file gas_exchange.h.

struct photomod::CGasExchange::tParms photomod::CGasExchange::sParms

double photomod::CGasExchange::StomatalConductance [protected]

stomatal conductance umol m-2 s-1
Definition at line 153 of file gas_exchange.h.

double photomod::CGasExchange::Tair [protected]

Air temperature at 2m, (C)
Definition at line 141 of file gas_exchange.h.

double photomod::CGasExchange::Tleaf [protected]

Leaf temperature C.
Definition at line 153 of file gas_exchange.h.

double photomod::CGasExchange::Transpiration [protected]

transpiration mol h2o m-2 s-1
Definition at line 153 of file gas_exchange.h.

double photomod::CGasExchange::VPD [protected]

Vapor Pressure Density, kPa */.
Definition at line 153 of file gas_exchange.h.

double photomod::CGasExchange::width [protected]

Leaf width (m)
Definition at line 141 of file gas_exchange.h.

double photomod::CGasExchange::wind `[protected]`

Windspeed at 2 meters (km s-1)

Definition at line 141 of file gas_exchange.h.

The documentation for this class was generated from the following files:

- **gas_exchange.h**
- **gas_exchange.cpp**

photomod::CGasExchange::tParms Struct Reference

tParms Structure to hold parameters for the model

`#include <gas_exchange.h>`

Public Attributes

- double **Eaj**
- double **Eap**
- double **Ear**
- double **EaVc**
- double **EaVp**
- double **g0**
- double **g1**
- double **Hj**
- double **Hv**
- string **ID**
- double **Jm25**
- double **LfAngFact**
- double **LfWidth**
- double **Rd25**
- std::string **Remark**
- double **Sj**
- std::string **species**
- double **stomaRatio**
- double **Sv**
- double **Theta**
- double **TPU25**
- std::string **Type**
- double **Vcm25**
- double **Vpm25**

Detailed Description

tParms Structure to hold parameters for the model

parameter description note some parameters are specific for C3 or C4 type Plants

Parameters:

ID	1 Name of plant
species	2 Species Name
type	3 C3 or C4
Vcm25	4 Photosynthetic Rubisco Capacity at 25C (umol m-2 s-1)
Jm25	5 Potential Rate of electron transport at 25C (umol m-2 s-1)
Vpm25	6 C4 Carboxylation rate at 25C (C4, umol m-2 s-1)
TPU25	7 Rate if Triose Phosphate Utilization at 25C (C3, umol m-2 s-1)
RD25	8 Mitochondrial respiration in the light at 25C (umol m-2 s-1)
theta	10 Initial slope of CO2 response (umol m2 s-1)
EaVc	11 Activation energy for Arrhenius function used to calculate temperature dependence for Vcmax (kJ mol-1)
Eaj	12 Activation energy for Arrhenius function used to calculate temperature dependence for J (kJ mol-1)

Hj	13 Curvature parameter of the temperature dpendence of Jmax (kJ mol-1)
Sj	14 Electron transport temperature response parameter for Jmax (J mole-1 K-1)
Hv	15 Curvature parameter of the temperature dependence of Vcmax (J mole-1)
EaVp	16 Activation energy for Arrhenius function used to calculate temperature dependence for Vpmax (kJ mol-1)
Sv	17 Electron transport temperature response parameter for Vcmax (J mole-1 K-1)
EAP	18 Activation energy for Arrhenius function used to calculate temperature dependence for TPU (kJ mol-1)
EAR	19 Activation energy for Arrhenius function used to calculate temperature dependence for respiration (kJ mol-1)
g0	20 Minimum stomatal conductance to water vapor at the light compensation point in the BWB model (mol m-2 s-1)
g1	21 Empirical coefficient for the sensitivity of StomatalConductance to A, Cs and hs in BWB model (no units?)
StomRatio	22 Stomatal Ratio
LfWidth	23 Leaf Width (m)
LfAngFact	24 Leaf Angle Factor
Remark	25 Text

Definition at line 93 of file gas_exchange.h.

Member Data Documentation

double photomod::CGasExchange::tParms::Eaj

Definition at line 100 of file gas_exchange.h.

double photomod::CGasExchange::tParms::Eap

Definition at line 100 of file gas_exchange.h.

double photomod::CGasExchange::tParms::Ear

Definition at line 100 of file gas_exchange.h.

double photomod::CGasExchange::tParms::EaVc

Definition at line 100 of file gas_exchange.h.

double photomod::CGasExchange::tParms::EaVp

Definition at line 100 of file gas_exchange.h.

double photomod::CGasExchange::tParms::g0

Definition at line 100 of file gas_exchange.h.

double photomod::CGasExchange::tParms::g1

Definition at line 100 of file gas_exchange.h.

double photomod::CGasExchange::tParms::Hj

Definition at line 100 of file gas_exchange.h.

double photomod::CGasExchange::tParms::Hv

Definition at line 100 of file gas_exchange.h.

string photomod::CGasExchange::tParms::ID

Definition at line 95 of file gas_exchange.h.

double photomod::CGasExchange::tParms::Jm25

Definition at line 100 of file gas_exchange.h.

double photomod::CGasExchange::tParms::LfAngFact

Definition at line 100 of file gas_exchange.h.

double photomod::CGasExchange::tParms::LfWidth

Definition at line 100 of file gas_exchange.h.

double photomod::CGasExchange::tParms::Rd25

Definition at line 100 of file gas_exchange.h.

std::string photomod::CGasExchange::tParms::Remark

Definition at line 120 of file gas_exchange.h.

double photomod::CGasExchange::tParms::Sj

Definition at line 100 of file gas_exchange.h.

std::string photomod::CGasExchange::tParms::species

Definition at line 96 of file gas_exchange.h.

double photomod::CGasExchange::tParms::stomaRatio

Definition at line 100 of file gas_exchange.h.

double photomod::CGasExchange::tParms::Sv

Definition at line 100 of file gas_exchange.h.

double photomod::CGasExchange::tParms::Theta

Definition at line 100 of file gas_exchange.h.

double photomod::CGasExchange::tParms::TPU25

Definition at line 100 of file gas_exchange.h.

std::string photomod::CGasExchange::tParms::Type

Definition at line 97 of file gas_exchange.h.

double photomod::CGasExchange::tParms::Vcm25

Definition at line 100 of file gas_exchange.h.

double photomod::CGasExchange::tParms::Vpm25

Definition at line 100 of file gas_exchange.h.

The documentation for this struct was generated from the following file:

- **gas_exchange.h**

File Documentation

gas_exchange.cpp File Reference

```
#include "stdafx.h"
#include "gas_exchange.h"
#include <cmath>
```

Namespaces

- **photomod**

Photosynthesis Model NameSpace. Macros

- #define **epsilon** 0.97
  emissivity See Campbell and Norman, 1998, page 163 (CHECK)
- #define **f** 0.15
  spectral correction
- #define **maxiter** 200
  maximum number of iterations
- #define **O** 205.0
  gas units are mbar
- #define **Q10** 2.0
  <Empirical Curvature factor for calculation of J Eq 5 in Soo, 200
- #define **R** 8.314
  idealgasconstant
- #define **sbc** 5.6697e-8
  stefan-Boltzmann constant Wm-2 k-4. Actually varies somewhat with temperature
- #define **scatt** 0.15
  leaf reflectance + transmittance

Functions

- double **photomod::Min** (double a, double b, double c)
- double **photomod::Square** (double a)

Macro Definition Documentation

#define epsilon 0.97

emissivity See Campbell and Norman, 1998, page 163 (CHECK)

Definition at line 21 of file gas_exchange.cpp.

#define f 0.15

spectral correction

Definition at line 24 of file gas_exchange.cpp.

#define maxiter 200

maximum number of iterations
Definition at line 20 of file gas_exchange.cpp.

#define O 205.0

gas units are mbar
Definition at line 25 of file gas_exchange.cpp.

#define Q10 2.0

<Empirical Curvature factor for calculation of J Eq 5 in Soo, 200
Q10 factor
Definition at line 28 of file gas_exchange.cpp.

#define R 8.314

idealgasconstant
Definition at line 19 of file gas_exchange.cpp.

#define sbc 5.6697e-8

stefan-Boltzmann constant Wm-2 k-4. Actually varies somewhat with temperature
Definition at line 22 of file gas_exchange.cpp.

#define scatt 0.15

leaf reflectance + transmittance
Definition at line 23 of file gas_exchange.cpp.

gas_exchange.h File Reference

```
#include "stdafx.h"
```

Classes

- class **photomod::CGasExchange**
- struct **photomod::CGasExchange::tParms**

tParms ***Structure to hold parameters for the model*** Namespaces

- **photomod**

Photosynthesis Model NameSpace.

Photosynthesis(notManaged).cpp File Reference

```
#include "stdafx.h"
#include "gas_exchange.h"
#include <iostream>
#include <fstream>
#include <algorithm>
#include <sstream>
```

Functions

- int **_tmain** (int argc, _TCHAR *argv[])

Function Documentation

int _tmain (int *argc*, _TCHAR * *argv*[])

< holds line of data read from file

< from parameter file

< needed to use strtok_s function

< parameters sent to photosynthesis module

< declare a photosynthesis object

< pointer to character (delimiter) that separates entries in the parameter file

< pointer to the next word to be read from parameter file

< variable to test if there are characters in the line of data (indicates end of data)

< Boolean to indicate the species line was found in the parameter file

< temporary variable for holding string objects

< files to hold parameters and variables for a single run

<holds data output from photosynthesis module

< Species of plant for calculatioins

Definition at line 29 of file Photosynthesis(notManaged).cpp.

stdafx.cpp File Reference

```
#include "stdafx.h"
```

stdafx.h File Reference

```
#include "targetver.h"
#include <stdio.h>
#include <tchar.h>
#include <atlbase.h>
#include <atlstr.h>
#include <string>
```

Macros

- #define **_ATL_CSTRING_EXPLICIT_CONSTRUCTORS**

Macro Definition Documentation

#define _ATL_CSTRING_EXPLICIT_CONSTRUCTORS

Definition at line 14 of file stdafx.h.

targetver.h File Reference

Macros

- #define **_WIN32_IE** 0x0700
- #define **_WIN32_WINDOWS** 0x0410
- #define **_WIN32_WINNT** 0x0600
- #define **WINVER** 0x0600

Macro Definition Documentation

#define _WIN32_IE 0x0700

Definition at line 23 of file targetver.h.

#define _WIN32_WINDOWS 0x0410

Definition at line 19 of file targetver.h.

#define _WIN32_WINNT 0x0600

Definition at line 15 of file targetver.h.

#define WINVER 0x0600

Definition at line 11 of file targetver.h.

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