

Package ‘AquaCropR’

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Title AquaCrop for R

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Maintainer Anyela V Camargo <anyelavcamargo@gmail.com>

Description The AquaCropR package is the R implementation of the AquaCrop crop growth model developed by FAO (<http://www.fao.org/aquacrop>) to address food security and assess the effect of the environment and management on crop production. AquaCrop simulates the yield response of herbaceous crops to water and is particularly well suited to conditions in which water is a key limiting factor in crop production. The AquaCrop model simulates final crop yield in four steps which consist on the simulation of development of green crop canopy cover, crop transpiration, above-ground biomass, and final crop yield. Temperature and water stresses directly affect one or more of the above processes.

Nutrient deficiencies and salinity effects are simulated indirectly by moderating canopy cover development over the season, and by reducing crop transpiration and the normalized water productivity. The effect of CO₂ concentration on biomass is simulated by altering the normalised water productivity.

AquaCrop requires a relatively small number of explicit parameter values such as weather and soil properties, and crop management practices.

Crop associated variables are normally known and are available for the majority of crops.

Imports XML, xml2, pracma, kulife, Rdpack, dplyr, elliptic

Depends R (>= 3.2.0)

License GPL-3

Encoding UTF-8

LazyData true

RoxygenNote 6.1.1

RdMacros Rdpack

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AboutUsingAquaCropR *About how to run the simulation and use Parameter Optimisation*

Description

About how to run the simulation and use Parameter Optimisation

Usage

AboutUsingAquaCropR()

Format

These are the steps to run your simulation:

First Create all the input files as specified in the [ReadFileLocations](#) section.

Second Use the ReadFileLocations() function to load your files into the model (e.g. F <- ReadFileLocations('FileLocation.xml'))

Third Use the `Initialise()` function to initialise your variables. Refer to the [Initialise](#) section to get familiar with the function (e.g. `I <- Initialise(F)`)

Fourth Use the `PerformSimulation()` function to perform the simulation. Refer to the [Perform-Simulation](#) section to get familiar with the function (e.g. `O <- PerformSimulation(I)`). `PerformSimulation` will output all the variables create by the model in the form of a list. Refer to [OutputParameters](#) for more information about these variables

Examples

```
F <- ReadFileLocations('FileSetup.xml')
I <- Initialise(F)
O <- PerformSimulation(I)
names(O)
```

Example of `FileSetup.xml` file:

```
<?xml version="1.0"?>
<FileSetup>
<Input>input/</Input>
<WeatherFilename>Weather.csv</WeatherFilename>
<CO2Filename>MaunaLoaCO2.csv</CO2Filename>
<ClockFilename>Clock.xml</ClockFilename>
<CropRotationFilename>CropRotation.xml</CropRotationFilename>
<FieldManagementFilename>FieldManagement.xml</FieldManagementFilename>
<InitialWCFilename>InitialWaterContent.xml</InitialWCFilename>
<GroundwaterFilename>WaterTable.xml</GroundwaterFilename>
<SoilFilename>Soil.xml</SoilFilename>
<CropRotationCalendarFilename>CropRotationCalendar.xml</CropRotationCalendarFilename>
</FileSetup>
```

AboutUsingParameterOptimisation

How to use Parameter Optimisation

Description

How to use Parameter Optimisation

Usage

`AboutUsingParameterOptimisation()`

Format

These are the steps to use parameter optimisation:

First Load observed data which should be a $n \times m$ matrix were columns area parameters and rows are observations at a given time point. The following parameters must be provided per observation:

day day dd

month month mm

year year yyy

obsbio Biomass (g m⁻²)

Second Create all the input files as specified in the [ReadFileLocations](#) section.

Third Use the ReadFileLocations() function to load your files into the model (e.g. F <- ReadFileLocations('FileLocation.xml'))

Fourth Use the Initialise() function to initialise your variables. Refer to the [Initialise](#) section to get familiar with the function (e.g. I <- Initialise(F))

Fifth Set optimiser parameters. AquaCropR uses DEoptim for parameter optimisation. Please refer to DEoptim's manual (<https://cran.r-project.org/web/packages/DEoptim/DEoptim.pdf>) to learn to setup optimiser parameters.

Sixth Parameter boundaries. A n X 2 matrix should be provided where rows are parameters (currently CCx and GCG only) and col1 and col2 are parameters' lower and upper boundaries. Matrix's rownames should be the name of the parameters to be optimised. See example below. NOTE: make sure you use the correct parameter's name as indicated earlier.

Seventh Use the SetOptimiser() function to perform the optimisation Refer to the [SetOptimiser](#) section to get familiar with the function (e.g. O <- SetOptimiser(param_array, InitialiseStruct, emp_data, control)). SetOptimiser will output the optimised parameters.

Eight Use optimised parameters in your Crop.xml file

Examples

```
##Read observed data
emp_data <- read.csv('input_calibrate/test_output.csv', header = TRUE)
##Set folder where files are located
folder_name <- dir(pattern='input_cali*')
##Read file locations
FileLocation = ReadFileLocations(paste(folder_name, '/', 'filesetup.xml',
                                         sep=''))

##Initialise structure
InitialiseStruct <- Initialise(FileLocation)
##Set optimisation parameters
control = DEoptim.control(itermax = 5)
##Set parameters boundaries (lower and upper limits)
CGC <- c(0.012494, 0.012494)
CCx <- c(0.94, 0.94)
param_array <- rbind(CGC, CCx)
##Call optimiser
opt_par <- SetOptimiser(param_array, InitialiseStruct, emp_data, control)
print(opt_par)
```

AdjustCCx

Adjust CCx value for changes in CGC due to water stress during the growing season, AquacropR

Description

Adjust CCx value for changes in CGC due to water stress during the growing season, AquacropR

Usage

```
AdjustCCx(CCprev, CCo, CCx, CGC, CDC, dt, tSum, Crop)
```

Arguments

CCprev	Prev Cannopy cover
CCo	initial canopy cover at the time of 90% crop emergence
CCx	Maximum canopy cover
CGC	Canopy growth coefficient
CDC	Canopy decline coefficient
dt	Delta time
tSum	tSum
Crop	Parameters for a given crop

Value

with CCxAdj for a n time-step.

Examples

```
AdjustCCx(CCprev, CCo, CCx, CGC, CDC, dt, tSum, Crop)
```

AerationStress	<i>Calculate aeration stress coefficient</i>
----------------	--

Description

Calculate aeration stress coefficient

Usage

```
AerationStress(Crop, InitCond, thRZ)
```

Arguments

Crop	Parameters for a given crop
InitCond	Crop setting initial structure
thRZ	aeration stress (root zone)

Value

list with NewCond and Ksa aeration stress coefficient for a n time-step.

Examples

```
AerationStress(Crop, InitCond, thRZ)
```

as_date	<i>Number of days from sdat to origin</i>
---------	---

Description

Number of days from sdat to origin

Usage

```
as_date(sdat)
```

Arguments

sdat	date in format "%Y-%m-%d"
------	---------------------------

as_datenum	<i>Number of days from sdat to origin</i>
------------	---

Description

Number of days from sdat to origin

Usage

```
as_datenum(sdat, o = "0000-01-01", f = "%Y-%m-%d")
```

Arguments

sdat	date in format "%Y-%m-%d" as default
o	origin
f	format

as_datenum_string	<i>Number of days from sdat to origin</i>
-------------------	---

Description

Number of days from sdat to origin

Usage

```
as_datenum_string(x)
```

Arguments

x	date where x should be in the format: x['Year'], x['Month'], x['Day']
---	---

as_date_list	<i>It's datavec in Matlab. Converts data in numeric format to date in vector format i.e. yyyy, m, d</i>
--------------	---

Description

It's datavec in Matlab. Converts data in numeric format to date in vector format i.e. yyyy, m, d

Usage

```
as_date_list(sdat, origin_value = "0000-01-01")
```

BiomassAccumulation	<i>Calculate biomass accumulation (g m-2)</i>
---------------------	---

Description

Calculate biomass accumulation (g m-2)

Usage

```
BiomassAccumulation(Crop, InitCond, Tr, TrPot, Et0, Tmax, Tmin, GDD, GrowingSeason)
```

Arguments

Crop	Parameters for a given crop
InitCond	Crop setting initial structure
Tr	actual transpiration
TrPot	potential transpiration
Et0	Evapotranspiration
Tmax	max temp for n time-step
Tmin	min temp for n time-step
GDD	Growing degree days
GrowingSeason	crop developmental stage

Value

NewCond for a n time-step.

Examples

```
BiomassAccumulation(Crop, InitCond, Tr, TrPot, Et0, Tmax, Tmin, GDD, GrowingSeason)
```

calcAVP

calculate Water vapour pressure (Kpa) according to FAO

Description

calculate Water vapour pressure (Kpa) according to FAO

Usage

calcAVP(x)

Arguments

x	list with three parameters x[[1]] = RH, x[[2]] = TMAX, x[[3]] = TMIN
AVP	actual vapour pressure

Examples

```
RH = 57.8
TMAX = 22.96
TMIN = 9.23
calcAVP(RH, TMAX, TMIN)
```

CalculateHIGC

Calculate harvest index growth coefficient.

Description

Calculate harvest index growth coefficient.

Usage

CalculateHIGC(Crop)

Arguments

Crop	list
------	------

Value

list with HIGC and tHI.

Examples

```
CalculateHIGC(Crop)
```

CalculateHILinear	<i>Calculate time to switch to linear harvest index build-up, and associated linear rate of build-up. Only for fruit/grain crops.</i>
-------------------	---

Description

Calculate time to switch to linear harvest index build-up, and associated linear rate of build-up. Only for fruit/grain crops.

Usage

```
CalculateHILinear(Crop)
```

Arguments

Crop	list
------	------

Value

list with tSwitch and dHILin.

Examples

```
CalculateHILinear(Crop)
```

calculate_sowingdate	<i>calculate sowingdate</i>
----------------------	-----------------------------

Description

calculate sowingdate

Usage

```
calculate_sowingdate(weather_data, start_date, end_date, thr = 5, day,
  month, year, P, year_list, Crop, ccl = 100)
```

Arguments

weather_data	weather data
start_date	start window 'dd/mm'
day	label in dataset
month	label in dataset
year	label in dataset
P	label irrigation
year_list	year to be analysed
Crop	crop name
ccl	crop calendar length

CanopyCover	<i>Simulate canopy growth/decline</i>
-------------	---------------------------------------

Description

Simulate canopy growth/decline

Usage

```
CanopyCover(Crop, Soil, InitCond, GDD, Et0, GrowingSeason)
```

Arguments

Crop	Parameters for a given crop
Soil	properties of soil
InitCond	Crop setting initial structure
GDD	Growing degree days
Et0	Evapotranspiration
GrowingSeason	crop developmental stage

Value

NewCond for a n time-step.

Examples

```
CanopyCover(Crop, Soil, InitCond, GDD, Et0, GrowingSeason)
```

CapillaryRise	<i>Calculate capillary rise from a shallow groundwater table</i>
---------------	--

Description

Calculate capillary rise from a shallow groundwater table

Usage

```
CapillaryRise(Soil, Groundwater, InitCond, FluxOut)
```

Arguments

Soil	properties of soil
Groundwater	ground water table
InitCond	Crop setting initial structure
FluxOut	Flux

Value

list with NewCond and CrTot for a n time-step.

Examples

CapillaryRise(Soil, Groundwater, InitCond, FluxOut)

CCDevelopment	<i>Calculate canopy cover development by end of the current simulation day</i>
---------------	--

Description

Calculate canopy cover development by end of the current simulation day

Usage

CCDevelopment(CCo, CCx, CGC, CDC, dt, Mode)

Arguments

CCo	CCDevelopment
CCx	Maximum canopy cover
CGC	Canopy growth coefficient
CDC	Canopy decline coefficient
dt	Canopy approaching maximum size
Mode	crop calendar mode

Value

CC canopy for a n time-step.

Examples

CCDevelopment(CCo, CCx, CGC, CDC, dt, Mode)

CCRequiredTime	<i>Function to find time required to reach CC at end of previous day, given current CGC or CDC</i>
----------------	--

Description

Function to find time required to reach CC at end of previous day, given current CGC or CDC

Usage

```
CCRequiredTime(CCprev, CCo, CCx, CGC, CDC, dt, tSum, Mode)
```

Arguments

CCprev	Prev Cannopy cover
CCo	Initial canopy cover at the time of 90% crop emergence
CCx	Maximum canopy cover
CGC	Canopy growth coefficient
CDC	Canopy decline coefficient
dt	delta time
tSum	tSum
Mode	Stage

Value

tReq equired time for a n time-step.

Examples

```
CCRequiredTime(CCprev, CCo, CCx, CGC, CDC, dt, tSum, Mode)
```

ChangeDateFormat	<i>change date format</i>
------------------	---------------------------

Description

change date format

Usage

```
ChangeDateFormat(x)
```

Arguments

x	date, where year = x[[1]], DOY = x[[2]]
---	---

Value

d

Examples

```

year = '2011'
DOY = 1
ChangeDateFormat(year, DOY)

```

CheckGroundwaterTable *Check for presence of a groundwater table, and, if present, to adjust compartment water contents and field capacities where necessary*

Description

Check for presence of a groundwater table, and, if present, to adjust compartment water contents and field capacities where necessary

Usage

```
CheckGroundwaterTable(Soil, Groundwater, InitCond, ClockStruct)
```

Arguments

Soil	structure of Soil
Groundwater	ground water table
InitCond	Crop setting initial structure
ClockStruct	Model time settings

Value

NewCond model values for n time-step

Examples

```
CheckGroundwaterTable(Soil, Groundwater, InitCond)
```

CheckModelTermination *Function to check and declare model termination*

Description

Function to check and declare model termination

Usage

```
CheckModelTermination(ClockStruct, InitialiseStruct)
```

Arguments

ClockStruct	the Clock list
InitialiseStruct	the crop initial conditions in list format

Value

ClockStruct.

Examples

CheckModelTermination(ClockStruct, InitialiseStruct)

check_file_exist	<i>check file exist and load</i>
------------------	----------------------------------

Description

check file exist and load

Usage

check_file_exist(filename)

Arguments

filename, file name

check_xml_exist	<i>check file exist and load</i>
-----------------	----------------------------------

Description

check file exist and load

Usage

check_xml_exist(filename)

Arguments

filename, file name

check_xml_table_exist	<i>check file exist and load</i>
-----------------------	----------------------------------

Description

check file exist and load

Usage

check_xml_table_exist(filename)

Arguments

filename, file name

ComputeCropCalendar	<i>Compute additional parameters needed to define crop</i>
---------------------	--

Description

Compute additional parameters needed to define crop

Usage

```
ComputeCropCalendar(Crop, CropName, CropChoices, Weather, ClockStruct)
```

Arguments

Crop	list
CropName	list with crops names
CropChoices	crops to be analysed
Weather	dataset with weather data
ClockStruct	crop calendar

Value

Crop.

Examples

```
ComputeCropCalendar(Crop, CropName, CropChoices, Weather, ClockStruct)
```

ComputeVariables	<i>Compute additional variables needed to run AquaCrop</i>
------------------	--

Description

Compute additional variables needed to run AquaCrop

Usage

```
ComputeVariables(ParamStruct, Weather, ClockStruct, GwStruct, CropChoices,
  FileLocation)
```

Arguments

ParamStruct	Crop Structure
Weather	Weather data
ClockStruct	Crop calendar
GwStruct	Ground water table
CropChoices	Crops to be analysed
FileLocation	list with file locations

Value

ParamStruct.

Examples

ComputeVariables(ParamStruct, Weather, ClockStruct, GwStruct, CropChoices, FileLocation)

conver2num	<i>Convert to numeric</i>
------------	---------------------------

Description

Convert to numeric

Usage

conver2num(sdata)

Arguments

sdata dataset

convertDOY	<i>convert to DOY</i>
------------	-----------------------

Description

convert to DOY

Usage

convertDOY(fdate)

Arguments

fdate date

Value

DOY

Examples

convertDOY('01-01-2000')

convert_list_2numeric	<i>convert list values to numeric</i>
-----------------------	---------------------------------------

Description

convert list values to numeric

Usage

```
convert_list_2numeric(slist, lnames = NULL)
```

Arguments

slist	list
lnames	field names to transform FIXME: do it for subsets

convert_table_list_2numeric	<i>convert list values to numeric</i>
-----------------------------	---------------------------------------

Description

convert list values to numeric

Usage

```
convert_table_list_2numeric(slist, lnames = NULL)
```

Arguments

slist	list
lnames	field names to transform FIXME: do it for subsets

Convert_to_List	<i>convert data.frame to list</i>
-----------------	-----------------------------------

Description

convert data.frame to list

Usage

```
Convert_to_List(sdat)
```

Arguments

sdat	data.frame
------	------------

CropParameters

*Crop Parameters to be provided in CropFile.***Description**

Crop Parameters to be provided in CropFile.

Usage

CropParameters()

Format

A file in xml format should be provided with the following fields. Guidance on appropriate parameter values for different crop types can be obtained from the FAO AquaCrop manual Steduto et al (2009), Agronomy Journal, 2009, 101, 426-437 or <https://github.com/anyelacamargo/AquaExamples/FAOCrops.pdf>

CropType Determines the category of crop Units: - Default value: 1 = Leafy vegetable; 2 = Root/tuber; 3 = Fruit/grain

CalendarType Determines time units for crop development Units: - Default value: 1 = Calendar days; 2 = GDD's

SwitchGDD Determines if inputs (when specified in calendar day mode) are converted to GDD's. Conversion is recommended to ensure accurate phenology. Units: - Default value: 0 = No 1 = Yes

PlantingDate Default planting date (may be overwritten) Units: dd/mm Default value: -

HarvestDate Default latest harvest date (may be overwritten) Units: dd/mm Default value: -

Emergence Time from sowing/transplanting to emergence/transplant recovery Units: Days/GDD's Default value: -

MaxRooting Time from sowing/transplanting to maximum root development Units: Days/GDD's Default value: -

Senescence Time from sowing/transplanting to start of canopy senescence Units: Days/GDD's Default value: -

Maturity Time from sowing/transplanting to physiological maturity Units: Days/GDD's Default value: -

HIstart Time from sowing/transplanting to start of yield formation Units: Days/GDD's Default value: -

Flowering Duration of flowering (only for fruit/grain crops) Units: Days/GDD's Default value: -

YldForm Duration of yield formation Units: Days/GDD's Default value: -

GDDmethod Method used to calculate GDD's Units: - Default value: -

Tbase Base temperature below which crop growth does not occur Units: oC Default value: -

Tupp Upper temperature above which crop growth does not occur Units: oC Default value: -

PolHeatStress Determines if pollination is affected by heat stress Units: - Default value: 0 = No; 1 = Yes

Tmax up Maximum temperature above which pollination begins to fail Units: oC Default value: -

Tmaxlo Maximum temperature above which pollination fails completely Units: oC Default value: -

-

- PolColdStress** Determines if pollination is affected by cold stress Units: - Default value: 0 = No; 1 = Yes
- Tmin up** Minimum temperature below which pollination begins to fail Units: oC Default value: -
- Tmin lo** Minimum temperature below which pollination fails completely Units: oC Default value: -
- BioHeatStress** Determines if biomass production is affected by temperature stress Units: - Default value: 0 = No; 1 = Yes
- GDD up** Minimum number of GDD's required for full biomass production Units: GDD's Default value: -
- GDD lo** Minimum number of GDD's required for any biomass production to occur Units: GDD's Default value: -
- fshape b** Shape factor describing the reduction in biomass production due to insufficient GDD's Units: GDD's Default value: -
- PctZmin** Percentage of minimum effective rooting depth at sowing/transplanting Units: % Default value: 70
- Zmin** Minimum effective rooting depth Units: Metres Default value: -
- Zmax** Maximum effective rooting depth Units: Metres Default value: -
- fshape r** Shape factor describing the decreasing speed of root expansion over time Units: - Default value: 1.5
- fshape ex** Shape factor describing the effects of water stress on root expansion Units: - Default value: -6
- SxTopQ** Maximum water extraction at the top of the root zone Units: m³ m⁻³ day⁻¹ Default value: -
- SxBotQ** Maximum water extraction at the bottom of the root zone Units: m³ m⁻³ day⁻¹ Default value: -
- a Tr** Exponent parameter describing the effect of canopy decline on transpiration/photosynthetic capacity Units: - Default value: 1
- SeedSize** Soil surface area covered by an individual seedling at 90% emergence Units: cm² Default value: -
- PlantPop** Plant population Units: plants ha⁻¹ Default value: -
- CCmin** Minimum fractional canopy cover size below which yield formation does not occur Units: - Default value: -
- CCx** Maximum fractional canopy cover size Units: - Default value: -
- CDC** Canopy decline coefficient Units: day⁻¹/GDD⁻¹ Default value: -
- CGC** Canopy growth coefficient Units: day⁻¹/GDD⁻¹ Default value: -
- Kcb** Maximum crop coefficient when canopy is fully developed Units: - Default value: -
- fage** Decline of crop coefficient due to ageing of the canopy Units: % day⁻¹ Default value: -
- WP** Water productivity normalised for reference evapotranspiration and atmospheric carbon dioxide Units: g m⁻² Default value: -
- WPy** Adjustment of water productivity parameter in yield formation stage Units: % of WP Default value: -
- fsink** Crop sink strength coefficient Units: - Default value: -
- bsted** Water productivity adjustment parameter for CO₂ effects given by (Steduto et al., 2007) Units: - Default value: 0.000138

- bface** Water productivity adjustment parameter for CO2 effects given by FACE experiments Units: - Default value: 0.001165
- HI0** Reference harvest index Units: - Default value: -
- HIini** Initial harvest index Units: - Default value: -
- dHI pre** Possible increase of harvest index due to pre-anthesis water stress Units: % Default value: -
- a HI** Coefficient describing the positive impact on harvest index of restricted vegetative growth post-anthesis Units: - Default value: -
- b HI** Coefficient describing the negative impact on harvest index of stomatal closure post-anthesis Units: - Default value: -
- dHI0** Maximum possible increase in harvest index above reference value Units: % Default value: -
- Determinant** Crop determinacy, which affects period of potential vegetative growth Units: - Default value: 0 = Indeterminant
- exc** Excess of potential fruits that is produced by the crop Units: % Default value: -
- MaxFlowPct** Percentage of total flowering period at which peak flowering occurs Units: % Default value: 33.33
- p up1** Upper soil water depletion threshold for water stress effects on canopy expansion Units: - Default value: -
- p up2** Upper soil water depletion threshold for water stress effects on stomatal control Units: - Default value: -
- p up3** Upper soil water depletion threshold for water stress effects on canopy senescence Units: - Default value: -
- p up4** Upper soil water depletion threshold for water stress effects on crop pollination Units: - Default value: -
- p lo1** Lower soil water depletion threshold for water stress effects on canopy expansion Units: - Default value: -
- p lo2** Lower soil water depletion threshold for water stress effects on stomatal control Units: - Default value: -
- p lo3** Lower soil water depletion threshold for water stress effects on canopy senescence Units: - Default value: -
- p lo4** Lower soil water depletion threshold for water stress effects on crop pollination Units: - Default value: -
- fshape w1** Shape factor describing water stress effects on canopy expansion Units: - Default value: -
- fshape w2** Shape factor describing water stress effects on stomatal control Units: - Default value: -
- fshape w3** Shape factor describing water stress effects on canopy senescence Units: - Default value: -
- fshape w4** Shape factor describing water stress effects on crop pollination Units: - Default value: -
- ETadj** Determines if water stress thresholds are adjusted for variations in daily reference evapotranspiration Units: Default value: 0 = No 1 = Yes
- Aer** Water deficit below saturation at which aeration stress begins to occur Units: % Default value: 5
- LagAer** Lag before aeration stress affects crop growth Units: days Default value: 3

beta Reduction to p lo3 parameter when early canopy senescence is triggered due to water stress
Units: % Default value: 12

GermThr Proportion of total available water needed in the root zone for the crop to germinate
Units: - Default value: 0.2

Drainage	<i>Redistribute stored soil water</i>
----------	---------------------------------------

Description

Redistribute stored soil water

Usage

Drainage(Soil, InitCond)

Arguments

Soil	structure characteristics
InitCond	Crop setting initial structure

Value

NewCond, DeepPerc and FluxOut for n time-step

Examples

Drainage(Soil, InitCond)

EvapLayerWaterContent	<i>Get water contents in the evaporation layer</i>
-----------------------	--

Description

Get water contents in the evaporation layer

Usage

EvapLayerWaterContent(InitCond, Soil, Wevap)

Arguments

InitCond	Crop setting initial structure
Soil	properties of soil
wevap	watwe evaporation

Value

Wevap for a n time-step.

Examples

```
EvapLayerWaterContent(InitCond, Soil, Wevap)
```

export_as_xml	<i>export dataframe as xml</i>
---------------	--------------------------------

Description

export dataframe as xml

Usage

```
export_as_xml(sdata, filename)
```

Arguments

sdata	dataset
filename	name of file

ExtractWeatherData	<i>Extract weather data for current time step.</i>
--------------------	--

Description

Extract weather data for current time step.

Usage

```
ExtractWeatherData(InitialiseStruct)
```

Arguments

InitialiseStruct	Crop setting initial structure
ClockStruct	crop calendar

Value

list with Weather for n time-step

Examples

```
ExtractWeatherData(ClockStruct, InitialiseStruct)
```

flowerfun	<i>Flower function</i>
-----------	------------------------

Description

Flower function

Usage

flowerfun(xx)

Arguments

xx parameter

Germination	<i>Check if crop has germinated</i>
-------------	-------------------------------------

Description

Check if crop has germinated

Usage

Germination(InitCond, Soil, Crop, GDD, GrowingSeason)

Arguments

InitCond	Crop setting initial structure
Soil	properties of soil
Crop	Parameters for a given crop
GDD	Growing degree days
GrowingSeason	crop developmental stage

Value

NewCond for a n time-step.

Examples

Germination(InitCond, Soil, Crop, GDD, GrowingSeason)

`get_atmospheric_pressure`*Calculate atmospheric pressure (P)*

Description

Calculate atmospheric pressure (P)

Usage`get_atmospheric_pressure(z)`**Arguments**

`z` elevation above sea level (m)

Value

P atmospheric pressure (kPa)

Examples`get_atmospheric_pressure(1800)`

`get_day`*get parameter day from date string*

Description

get parameter day from date string

Usage`get_day(x)`**Arguments**

`x` date, where year = `x[[1]]`, DOY = `x[[2]]`

Value

day of the month

get_ea_dp	<i>Calculate actual vapor pressure (ea) derived from dewpoint temperature</i>
-----------	---

Description

Calculate actual vapor pressure (ea) derived from dewpoint temperature

Usage

```
get_ea_dp(Tdew)
```

Arguments

Tdew	Dewpoint temperature (oC)
------	---------------------------

Value

ea

Examples

```
get_ea_dp(14.65)
```

get_ea_rh	<i>Calculate actual vapor pressure (ea) derived from mean relative humidity</i>
-----------	---

Description

Calculate actual vapor pressure (ea) derived from mean relative humidity

Usage

```
get_ea_rh(rh, eoTmax, eoTmin)
```

Arguments

rh	relative humidity (%)
eoTmax	saturation vapour Tmax
eoTmin	saturation vapour Tmin

Value

ea

Examples

```
get_ea_rh(57.44)
```

`get_Eto`*Calculate ETo using Penman_Monteith*

Description

Calculate ETo using Penman_Monteith

Usage

```
get_Eto(x)
```

Arguments

`x` weather parameters Tmax = `x[[1]]`, Tmax <- `x[[1]]`, Tmin <- `x[[2]]`, RA <- `x[[3]]`, Wind <- `x[[4]]`, Tdew <- `x[[5]]`, altitude <- `x[[6]]` = max temperature

Examples

```
get_Eto(x)
```

`get_month`*get parameter month from date string*

Description

get parameter month from date string

Usage

```
get_month(x)
```

Arguments

`x` date, where year = `x[[1]]`, DOY = `x[[2]]`

Value

month of the year

get_net_radiation	<i>Calculate net radiation mm/day</i>
-------------------	---------------------------------------

Description

Calculate net radiation mm/day

Usage

```
get_net_radiation(Tmax, Tmin, RA, altitude, easqrt)
```

Arguments

Tmax	max temperature
Tmin	min temperature
RA	solar radiation, all Sky Insolation Incident on a Horizontal Surface (MJ/m ² /day)
altitude	(m)
easqrt	sqrt(ea)

Value

rn_mm_day mm/day

Examples

```
get_net_radiation(29.5, 18.88, 27.47, 83.64)
```

get_slope_saturation_vp	<i>Slope of saturation vapour pressure curve</i>
-------------------------	--

Description

Slope of saturation vapour pressure curve

Usage

```
get_slope_saturation_vp(Tmean)
```

Arguments

Tmean	mean temperature (oC)
-------	-----------------------

Value

delta Slope of saturation vapour pressure curve T(kPa oC-1)

Examples

```
get_slope_saturation_vp(1800)
```

get_stefan_Boltzmann	<i>get stefan Boltzmann temp</i>
----------------------	----------------------------------

Description

get stefan Boltzmann temp

Usage

get_stefan_Boltzmann(t)

Arguments

t	temperature
---	-------------

Value

temperature

Examples

get_stefan_Boltzmann(14.88)

get_year	<i>get parameter year from date string</i>
----------	--

Description

get parameter year from date string

Usage

get_year(x)

Arguments

x	date, where year = x[[1]], DOY = x[[2]]
---	---

Value

year

GroundwaterInflow	<i>Calculate capillary rise in the presence of a shallow groundwater table</i>
-------------------	--

Description

Calculate capillary rise in the presence of a shallow groundwater table

Usage

GroundwaterInflow(Soil, InitCond)

Arguments

Soil	properties of soil
InitCond	Crop setting initial structure

Value

list with NewCond and GwIn groundwater inflow for a n time-step.

Examples

GroundwaterInflow(Soil, InitCond)

GrowingDegreeDay	<i>Calculate number of growing degree days on current day.</i>
------------------	--

Description

Calculate number of growing degree days on current day.

Usage

GrowingDegreeDay(Crop, InitCond, Tmax, Tmin)

Arguments

Crop	structure
InitCond	initial crop settings
Tmax	max temperature for n time-step
Tmin	min temperature for n time-step

Value

list with NewCond and GDD for n time-step

Examples

GrowingDegreeDay(Crop, InitCond, Tmax, Tmin)

GrowthStage	<i>Calculate number of growing degree days on current day</i>
-------------	---

Description

Calculate number of growing degree days on current day

Usage

GrowthStage(Crop, InitCond, GrowingSeason)

Arguments

Crop	Parameters for a given crop
InitCond	Crop setting initial structure
GrowingSeason	crop developmental stage

Value

NewCond for a n time-step.

Examples

GrowthStage(Crop, InitCond, GrowingSeason)

HarvestIndex	<i># Function to simulate build up of harvest index</i>
--------------	---

Description

Function to simulate build up of harvest index

Usage

HarvestIndex(Soil, Crop, InitCond, Et0, Tmax, Tmin, GDD, GrowingSeason)

Arguments

Soil	properties of soil
Crop	Parameters for a given crop
InitCond	Crop setting initial structure
Et0	Evapotranspiration
Tmax	max temp for n time-step
Tmin	min temp for n time-step
GDD	Growing degree days
GrowingSeason	crop developmental stage

Value

NewCond for a n time-step.

Examples

```
HarvestIndex(Soil, Crop, InitCond, Et0, Tmax, Tmin, GDD, GrowingSeason)
```

HIadjPollination	<i>Calculate adjustment to harvest index for failure of pollination due to water or temperature stress</i>
------------------	--

Description

Calculate adjustment to harvest index for failure of pollination due to water or temperature stress

Usage

```
HIadjPollination(InitCond, Crop, Ksw, Kst, HIit)
```

Arguments

InitCond	Crop setting initial structure
Crop	Parameters for a given crop
Ksw	Water stress
Kst	Temperature stress
HIit	Harvest index on current day

Value

with NewCond for a n time-step.

Examples

```
HIadjPollination(InitCond, Crop, Ksw, Kst, HIit)
```

HIadjPostAnthesis	<i>Function to calculate adjustment to harvest index for post-anthesis water stress</i>
-------------------	---

Description

Function to calculate adjustment to harvest index for post-anthesis water stress

Usage

```
HIadjPostAnthesis(InitCond, Crop, Ksw)
```


Arguments

InitCond	Crop setting initial structure
Crop	Parameters for a given crop
Ksw	

Value

NewCond for a n time-step.

Examples

```
HIadjPostAnthesis(InitCond, Crop, Ksw)
```

HIadjPreAnthesis	<i>Function to calculate adjustment to harvest index for pre-anthesis water stress</i>
------------------	--

Description

Function to calculate adjustment to harvest index for pre-anthesis water stress

Usage

```
HIadjPreAnthesis(InitCond, Crop)
```

Arguments

InitCond	Crop setting initial structure
Crop	Parameters for a given crop

Value

NewCond for a n time-step.

Examples

```
HIadjPreAnthesis(InitCond, Crop)
```

HlrefCurrentDay	<i>Calculate reference (no adjustment for stress effects) harvest index on current day</i>
-----------------	--

Description

Calculate reference (no adjustment for stress effects) harvest index on current day

Usage

```
HlrefCurrentDay(InitCond, Crop, GrowingSeason)
```

Arguments

InitCond	Crop setting initial structure
Crop	Parameters for a given crop
GrowingSeason	crop developmental stage

Value

NewCond for a n time-step.

Examples

```
HlrefCurrentDay(InitCond, Crop, GrowingSeason)
```

Infiltration	<i>Infiltrate incoming water (rainfall and irrigation)</i>
--------------	--

Description

Infiltrate incoming water (rainfall and irrigation)

Usage

```
Infiltration(Soil, InitCond, Infl, Irr, IrrMngt, FieldMngt, FluxOut,  
DeepPerc0, Runoff0)
```

Arguments

Soil	properties of soil
InitCond	Crop setting initial structure
Infl	Infiltration
Irr	Irrigation
IrrMngt	Irrigation management
FieldMngt	Field management
FluxOut	Flux
DeepPerc0	Deep percolation
Runoff	water Runoff

Value

list with NewCond, DeepPerc, RunoffTot, Infl and FluxOut for a n time-step.

Examples

```
Infiltration(Soil, InitCond, Infl, Irr, IrrMngt, FieldMngt, FluxOut, DeepPerc0, Runoff0)
```

Initialise

Function to initialise AquaCropR

Description

Function to initialise AquaCropR

Usage

```
Initialise(FileLocation)
```

Arguments

filename An xml file with locations

Value

list with FileLocation.

Examples

```
ReadFileLocations('dummy.xml')
```

Irrigation

Get irrigation depth for current day

Description

Get irrigation depth for current day

Usage

```
Irrigation(InitCond, IrrMngt, Crop, Soil, ClockStruct, GrowingSeason, P,
Runoff)
```

Arguments

InitCond	Crop setting initial structure
IrrMngt	Irrigation management
Crop	parameters for a given crop
Soil	properties of soil
ClockStruct	crop calendar
GrowingSeason	crop developmental stage
P	precipitation
Runoff	water Runoff

Value

list with NewCond and Irr for a n time-step.

Examples

```
Irrigation(InitCond, IrrMngt, Crop, Soil, ClockStruct, GrowingSeason, P, Runoff)
```

IrrigationManagementParameters

Irrigation Management Parameters

Description

Irrigation Management Parameters

Usage

```
IrrigationManagementParameters()
```

Format

The irrigation management file defines the input variables controlling irrigation practices in AquaCrop file in xml format should be provided with the following fields:

IrrSchFilename File name of an irrigation schedule. This file will only be used if triggering irrigation based on an input time series. When writing the file, the following information should be provided:

day

month

year

irrigationDepth mm

IrrMethod Method of irrigation, where:

0 rainfed

1 irrigation based on soil moisture status

2 irrigation on a fixed interval

3 pre-specified irrigation time-series

4 net irrigation

IrrInterval Time interval between irrigation events (days), if triggering based on a fixed interval

SMT1 Percentage of total available water at which irrigation is initiated in the first of the four main crop growth stages, if triggering based on soil moisture status.

SMT2 Percentage of total available water at which irrigation is initiated in the second of the four main crop growth stages, if triggering based on soil moisture status.

SMT3 Percentage of total available water at which irrigation is initiated in the third of the four main crop growth stages, if triggering based on soil moisture status.

SMT4 Percentage of total available water at which irrigation is initiated in the fourth of the four main crop growth stages, if triggering based on soil moisture status.

MaxIrr Maximum irrigation depth (mm day⁻¹).

AppEff Irrigation application efficiency (%).

NetIrrSMT Percentage of total available water to maintain when in net irrigation mode.

WetSurf Soil surface area wetted by irrigation (%).

When multiple crop types are considered in a single simulation, a unique irrigation management file can be created, and is assigned to each crop type in the crop rotation file.

 NNINDEX

Compute Nitrogen Nutrition Index

Description

Compute Nitrogen Nutrition Index

Usage

NNINDEX(TIME, DOYEM, EMERG, NFGMR, NRMR, NOPTMR, NNI)

Arguments

TIME	time point
DOYEM	day of emergence
EMERG	has the crop emerged? yes = 1; no = 0;
NFGMR	NUPGMR (Total N in green matter of the plant) / TBGMR (Total living vegetative biomass.)
NRMR	Average residual N concentration
NOPTMR	Maximum N content in the plant
NNI	Nutrition Index (NNI)

Value

NNI

 OutputParameters

OutputParameters to be provided in at the end of the simulation

Description

OutputParameters to be provided in at the end of the simulation

Usage

OutputParameters()

Format

A dataset with the following variables will be provided as output of the AquaCropR simulation:

Water contents output file The water contents list reports the simulated water content (m³ m⁻³) in each soil compartment at the end of each simulation day. A variable, 'Season', is also reported that takes a value of 1 on days during a growing season, and a value of 0 on days outside a growing season. Note that if the soil water balance is not simulated in the off-season, water contents on these days will be denoted by zero values

Water fluxes output file The water fluxes list provides various simulated water fluxes and states on each simulation day, including:

wRZ Water in the crop root zone (mm)

zGW Water table depth (m). A value of -999 indicates no groundwater table was considered

wSurf Pondered water (mm)

Irr TotIrr (mm)

Infl Infiltration (mm)

DP Deep percolation below the base of the soil profile (mm)

CR Capillary rise in to the soil profile (mm)

GWin Horizontal groundwater inflow to the soil profile (mm)

Es Soil evaporation (mm)

EsX Potential soil evaporation (mm)

Tr Crop transpiration (mm)

TrX Potential crop transpiration (mm)

Et0 Reference Evapotranspiration (mm)

Crop growth output file The crop growth output list reports various simulated aspects of crop development on each simulation day, including:

GDD Number of growing degree days on the current day

TotGDD Cumulative growing degree days in the current season

RootDepth Crop effective rooting depth (m)

CC Fractional canopy cover

RefCC Fractional canopy cover under no water-stress conditions

Bio Accumulated aboveground biomass (g m⁻²)

RefBio Accumulated aboveground biomass under no water stress conditions (g m⁻²)

HI Fractional reference harvest index

HIadj Fractional harvest index adjusted for water stress effects

Yield Crop yield (tonne ha⁻¹)

PlantingDate Calendar planting date (dd/mm/yyyy)

As previously noted, the variable 'Season' denotes whether a growing season was active on a given day and values of zero are assigned to all fluxes/states outside of the growing season if the off-season soil water balance is not simulated.

ParamCalibration	<i>Perform optimisation</i>
------------------	-----------------------------

Description

Perform optimisation

Usage

ParamCalibration(param)

Arguments

parameters to test in model

Examples

Param_calibration(param)

PerformSimulation	<i>Perform simulation</i>
-------------------	---------------------------

Description

Perform simulation

Usage

PerformSimulation(InitialiseStruct)

Arguments

InitialiseStruct
Crop setting initial structure

Value

list with Outputs results.

Examples

PerfomSimulation(InitialiseStruct)

PerformSimulationOptimisation
Perform Optimisation

Description

Perform Optimisation

Usage

PerformSimulationOptimisation(x, InitialiseStruct)

Arguments

InitialiseStruct
 Crop setting initial structure

Value

list with Outputs results.

Examples

PerformSimulationOptimisation(InitialiseStruct)

PreIrrigation *Calculate pre-irrigation when in net irrigation mode*

Description

Calculate pre-irrigation when in net irrigation mode

Usage

PreIrrigation(Soil, Crop, IrrMngt, InitCond)

Arguments

Soil	structure characteristics
Crop	crop settings
IrrMngt	irrigation management settings
InitCond	Crop setting initial structure

Value

list with NewCond and PreIrr for n time-step

Examples

PreIrrigation((Soil, Crop, IrrMngt, InitCond)

RainfallPartition	<i>Partition rainfall into surface runoff and infiltration</i>
-------------------	--

Description

Partition rainfall into surface runoff and infiltration

Usage

```
RainfallPartition(P, Soil, FieldMngt, InitCond)
```

Arguments

P	precipitation
Soil	structure characteristics
InitCond	Crop setting initial structure
IrrMngt	Irrigation management

Value

list with NewCond, Runoff and Infl for n time-step

Examples

```
RainfallPartition(P, Soil, FieldMngt, InitCond)
```

ReadClockParameters	<i>Read input files and initialise model clock parameters</i>
---------------------	---

Description

Read input files and initialise model clock parameters

Usage

```
ReadClockParameters(FileLocation)
```

Arguments

FileLocation	list with file locations
--------------	--------------------------

Value

ClockStruct crop calendar.

Examples

```
ReadClockParameters(FileLocation)
```

ReadFieldManagement	<i>Read input files and initialise model clock parameters</i>
---------------------	---

Description

Read input files and initialise model clock parameters

Usage

```
ReadFieldManagement(FileLocation)
```

Arguments

FileLocation list with file locations

Value

FieldManagement list.

Examples

```
ReadFieldManagement(FileLocation)
```

ReadFileLocations	<i>Read files input and output file locations</i>
-------------------	---

Description

Read files input and output file locations

Usage

```
ReadFileLocations(filename)
```

Arguments

filename An xml file with locations

Format

An xml file should be provided with the following fields

Input Files location

ClockFilename Name of clock file (xml format) which is used to set the duration of the simulation.

When writing the file, the following information should be provided:

SimulationStartTime Time when the simulation starts (yyyy-mm-dd)

SimulationEndTime Time when the simulation ends (yyyy-mm-dd)

OffSeason Specifies whether (as 'Y' or 'N') Soil water balance is simulated outside the growing season

WeatherFilename Name of weather input file (csv format) which defines time-series of daily weather inputs. When writing the file, the following information should be provided in comma separated format:

day day
month month
year year
mintp Day Minimum Temperature (oC)
mxtp Day Maximum Temperature (oC)
p Daily precipitation (mm)
evp Daily reference evapotranspiration (mm)

CO2Filename Name of Annual CO2 file (csv format) which contains time-series of atmospheric carbon dioxide (CO2) concentrations. When writing the file, the following information should be provided in comma separated format:

year year
co2 CO2 concentration (ppm)

SoilFilename Name of Soil file (xml format) which defines the input variables needed to parameterise the soil components in the model. When writing the file, the following file's names, as well as the variables listed in the [SoilParameters](#) section, should be provided.

SoilProfileFilename Name of Soil profile name (xml format) which defines the discretisation of the soil profile in to compartments and layers. When writing the file, the following information should be provided.

CompartmentNo Soil compartment number
Thickness Compartment thickness (m)
LayerNo Associated soil layer number

SoilTextureFilename Name of Soil Texture file (xml format) which calculates soil hydraulic properties from textural properties. If the user specifies in the soil input file to calculate soil hydraulic properties from textural properties, the soil texture input file must be provided. The soil texture input file defines the textural properties of each soil layer, which are then assigned to individual soil compartments according to the discretisation of the soil profile. When writing the file, the following information should be provided:

LayerNo Soil layer number
Thickness Thickness of the layer (m)
Sand Sand content (%)
Clay Clay content (%)
OrgMat t (% by weight)
DensityFactor default value of 1

Note. The number of data rows should match the number of soil layers specified in the soil input file. Using these input values, AquaCrop calculates the hydraulic properties of each soil layer (water contents at saturation, field capacity, and permanent wilting, along with the saturated hydraulic conductivity) based on the pedotransfer function model https://en.wikipedia.org/wiki/Pedotransfer_function.

SoilHydrologyFilename Name of FieldManagement file (xml format). If the user specifies in the soil input file that soil hydraulic properties are pre-defined, a soil hydrology input file must be provided. When writing the file, the following information should be provided:

LayerNo Soil layer number
LayerThickness Thickness of the layer (m)
thS Water content at saturation (m3 m-3)
thF Water content at field capacity (m3 m-3)

thWP Water content at permanent wilting point (m³ m⁻³)

Ksat Saturated hydraulic conductivity (mm day⁻¹)

Note: The number of data rows should equal exactly the number of soil layers specified in the soil input file.

CropRotationFilename Name of Crop Rotation file (xml format) which defines the crop types and any specified rotation to be simulated. When writing the file, the following information should be provided:

NumberofCropOptions Number of crop types modelled

SpecifiedPlantingCalendar If a crop rotation calendar is specified, denoted by a 'Y' or 'N' character

CropInfo Information about each crop should be provided through these variables:

croptype Crop name

CropFilename Crop input filename in xml format. The crop file defines the input variables needed to parameterise the crop component of AquaCrop. A unique version of the crop input file should be created for each individual crop type modelled during the simulation period, as defined by the variables **NumberofCropOptions** and **CropRotationCalendarFilename**. When writing the file, the variables listed in [CropParameters](#) should be provided

IrrigationFilename Irrigation management input filename in xml format. When writing the file, the variables listed in the [IrrigationManagementParameters](#) section should be provided.

A rotation calendar must be specified if more than one crop type is considered. When a rotation calendar is specified, the planting and latest harvest dates specified in each crop input file will be overwritten by the values given in the rotation calendar

FieldManagementFilename Name of FieldManagement file (xml format) which defines the input variables controlling field management practices in the model. When writing the file, the following information should be provided

Mulches If the soil surface is covered by mulches, where '0' is 'No' and '1' is 'Yes'.

MulchPctGS Soil surface area (%) covered by any mulches during the growing season.

MulchPctOS Soil surface area (%) covered by any mulches during the off season.

fMulch Factor defining the proportional reduction of soil evaporation due to presence of mulches.

Bunds If soil bunds are present on the field, where '0' is 'No' and '1' is 'Yes'.

zBund Height of any soil bunds (m).

BundWater Initial depth of water between any soil bunds (mm).

GroundwaterFilename Name of Groundwater file (xml format) which defines any shallow water table conditions that may influence soil moisture levels

Watertable_present If water table is present, denoted by a 'Y' or 'N' character

Watertable_method If a water table is present, whether it is 'Constant' or 'Variable'.

observations Observations of groundwater, where each observation contains two variables:

date (dd/mm/yyyy)

depth Water table depth (m)

InitialWCFilename Name of Initial Water Content file (xml format) which defines the initial moisture conditions throughout the soil profile at the start of the simulation, and also at the beginning of each growing season if the model does not simulate the soil water balance in the off-season. When writing the file, the following information should be provided:

type_of_value Format in which soil moisture input data is provided. Options available are to specify values based on:

Prop soil hydraulic properties

Num numerical values

Pct percentages of total available water

method Method used to calculate compartment water contents. If method is depth-based ('Depth'), observations will be linearly interpolated to the centre of each compartment. Alternatively, a layer-based method ('Layer') will apply uniform values to all compartments within a soil layer

number_of_input_points Number of input soil moisture data points

input_data_points Soil moisture data observations, where each row contains two variables:

depth_layer Point depth (m) or layer number

value Soil moisture value (defined format). If the format of soil moisture values is:

Prop values must be specified as either 'SAT' (Saturation), 'FC' (Field capacity), or 'WP' (Wilting point)

Num values must have units of m³ m⁻³

Pct values must have units of %

CropRotationCalendarFilename Name of Crop Rotation file (xml format). If the user specifies multiple crop types in the CropRotationFile or wishes to consider variable planting dates over a multi-season simulation, a crop rotation input file must be provided that defines the time series of growing seasons that will be simulated by AquaCrop. When writing the file, the following information should be provided:

PlantDate Planting date (dd/mm/yyyy)

HarvestDate Latest possible harvest date (dd/mm/yyyy)

Crop Crop type

Data only need to be specified for days when irrigation occurs. AquaCrop will automatically apply zero irrigation values to all other simulation days.

Value

list with FileLocation

Examples

```
ReadFileLocations('dummy.xml')
```

ReadGroundwaterTable *Read input file and initialise groundwater table parameters*

Description

Read input file and initialise groundwater table parameters

Usage

```
ReadGroundwaterTable(FileLocation, ClockStruct)
```

Arguments

FileLocation list with file locations

ClockStruct crop calendar

Value

GwStruct water table.

Examples

```
ReadGroundwaterTable(FileLocation, ClockStruct)
FIXME there is a bug here
```

```
ReadIrrigationManagement
```

Compute additional variables needed to run AOS

Description

Compute additional variables needed to run AOS

Usage

```
ReadIrrigationManagement(ParamStruct, FileLocation, ClockStruct)
```

Arguments

ParamStruct	Crop parameters structure
FileLocation	list with file locations
ClockStruct	crop calendar

Value

ParamStruct.

Examples

```
ReadIrrigationManagement(ParamStruct, FileLocation, ClockStruct)
```

```
ReadModelInitialConditions
```

Set up initial model conditions

Description

Set up initial model conditions

Usage

```
ReadModelInitialConditions(ParamStruct, GwStruct, FieldMngtStruct,
    CropChoices, FileLocation, ClockStruct)
```

Arguments

ParamStruct	Crop details
GwStruct	Water table details
FieldMngtStruct	field management structure
CropChoices	crops whose performance is to be modelled
FileLocation	file locations
ClockStruct	crop calendar structure

Value

InitCondStruct with intial conditions.

Examples

ReadModelInitialConditions(ParamStruct, GwStruct, FieldMngtStruct, CropChoices, FileLocation, ClockStruct)

ReadModelParameters	<i>Read input files and initialise soil and crop parameters</i>
---------------------	---

Description

Read input files and initialise soil and crop parameters

Usage

ReadModelParameters(FileLocation, ClockStruct)

Arguments

FileLocation	list with file locations
ClockStruct	crop calendar

Value

list with uodated ClockStruct ParamStruct and CropChoices.

Examples

ReadModelParameters(FileLocation, ClockStruct)

ReadWeatherInputs	<i>Read and process input weather time-series</i>
-------------------	---

Description

Read and process input weather time-series

Usage

```
ReadWeatherInputs(FileLocation, ClockStruct)
```

Arguments

FileLocation	file locations
ClockStruct	list time

Value

list with WeatherDB.

Examples

```
ReadWeatherInputs(FileLocation, ClockStruct)
```

ResetInitialConditions	<i>Reset initial model conditions for start of growing</i>
------------------------	--

Description

Reset initial model conditions for start of growing

Usage

```
ResetInitialConditions(InitialiseStruct, ClockStruct)
```

Arguments

InitialiseStruct	Crop setting initial structure
ClockStruct	crop calendar

Value

list with InitialiseStruct and ClockStruct for a n time-step

Examples

```
ResetInitialConditions(InitialiseStruct, ClockStruct)
```

RootDevelopment	<i>Calculate root zone expansion</i>
-----------------	--------------------------------------

Description

Calculate root zone expansion

Usage

RootDevelopment(Crop, Soil, GroundWater, InitCond, GDD, GrowingSeason)

Arguments

Crop	Parameters for a given crop
Soil	properties of soil
InitCond	Crop setting initial structure
GDD	Growing degree days
GrowingSeason	crop developmental stage
Groundwater	ground water table

Value

NewCond for a n time-step.

Examples

RootDevelopment(Crop, Soil, GroundWater, InitCond, GDD, GrowingSeason)

RootZoneWater	<i>Calculate actual and total available water in the root</i>
---------------	---

Description

Calculate actual and total available water in the root

Usage

RootZoneWater(Soil, Crop, InitCond)

Arguments

Soil	properties of soil
Crop	parameters for a given crop
InitCond	Crop setting initial structure

Value

list with Wr, Dr, TAW and thRZ for a n time-step.

Examples

RootZoneWater(Soil, Crop, InitCond)

SetOptimiser	<i>Set optimiser</i>
--------------	----------------------

Description

Set optimiser

Usage

SetOptimiser(param_array, InitialiseStruct, emp_data, op_settings)

Arguments

- param_array n x m matrix where n are parameters and m are cols indicating minimum and maximum value for each parameter
- InitialiseStruct Crop setting initial structure
- emp_data empirical data to calibrate model
- op_settings optimiser settings

Value

best paramaters

Examples

set_optimiser(param_array, InitialiseStruct, emp_data, op_settings)

SoilEvaporation	<i>Calculate daily soil evaporation in AOS</i>
-----------------	--

Description

Calculate daily soil evaporation in AOS

Usage

SoilEvaporation(ClockStruct, Soil, Crop, IrrMngt, FieldMngt, InitCond, Et0, Infl, Rain, Irr, GrowingSeason)

Arguments

ClockStruct	crop calendar
Soil	properties of soil
Crop	Parameters for a given crop
IrrMngt	Irrigation management
FieldMngt	Field management
InitCond	Crop setting initial structure
Et0	Evapotranspiration
Infl	Infiltration
Irr	Irrigation
GrowingSeason	crop developmental stage
P	precipitation

Value

list with NewCond, EsAct actual evaporation and EsPot potential soil evaporation for a n time-step.

Examples

```
SoilEvaporation(ClockStruct, Soil, Crop, IrrMngt, FieldMngt, InitCond, Et0, Infl, Rain, Irr, GrowingSeason)
```

SoilHydraulicProperties

Calculate soil hydraulic properties, given textural inputs. Calculations use pedotransfer function equations described in Saxton and Rawls (2006)

Description

Calculate soil hydraulic properties, given textural inputs. Calculations use pedotransfer function equations described in Saxton and Rawls (2006)

Usage

```
SoilHydraulicProperties(Soil)
```

Arguments

Soil	properties of soil
------	--------------------

Value

list with thdry, thwp, hfc, ths and ksa for a n time-step.

Examples

```
SoilHydraulicProperties(Soil)
```

SoilParameters

*Soil Parameters to be provided in SoilFile***Description**

Soil Parameters to be provided in SoilFile

Usage

SoilParameters()

Format

An .csv file should be provided with the following fields

CalcSHP Determines if soil hydraulic properties are calculated from textural characteristics of soil layers Units:0 = No; 1 = Yes Default value: -

zSoil Total thickness of the soil profile Units:Metres Default value: -

nComp Number of soil compartments Units:- Default value: -

nLayer Number of soil layers Units:- Default value: -

EvapZsurf Thickness of the evaporating soil surface layer in direct contact with the atmosphere Units:Metres Default value: 0.04

EvapZmin Minimum thickness of full soil surface evaporation layer Units:Metres Default value: 0.15

EvapZmax Maximum thickness of full soil surface evaporation layer Units:Metres Default value: 0.3

Kex Maximum soil evaporation coefficient Units:- Default value: 1.1

fevap Shape factor describing the reduction in evaporation with decreasing water content in the soil surface layer Units:- Default value: 4

fWrelExp Relative water content of the soil surface layer at which the evaporation layer depth expands Units:- Default value: 0.4

fwcc Coefficient expressing the reduction in soil evaporation due to the sheltering effect of withered canopy cover Units:- Default value: 0.5

AdjREW Determines if the calculated value of readily evaporable water (REW) is overwritten by a user-defined value Units:0 = No, 1 = Yes Default value:

REW User-defined REW depth (only used if adjusting from the calculated value) Units:Millimetres Default value: -

AdjCN Determines if the curve number (CN) is adjusted each day based on surface moisture conditions Units:0 = No, 1 = Yes Default value: -

CN Curve number Units:- Default value: -

zCN Thickness of the soil surface layer used to calculate moisture content to adjust the curve number Units:Metres Default value: 0.3

zGerm Thickness of the soil surface layer used to calculate moisture content to determine if germination can occur Units:Metres Default value: 0.3

zRes Depth of any restrictive soil layer that inhibits root deepening Units:Metres Default value: Set to negative value if no restriction is present

fshape_cr Shape factor describing the strength of the effect of any shallow groundwater table on soil water content Units:- Default value: 16

Solution	<i>Run AquaCrop for a n time step</i>
----------	---------------------------------------

Description

Run AquaCrop for a n time step

Usage

Solution(Weather, InitialiseStruct)

Arguments

Weather	weather parameters or n time-step
InitialiseStruct	Crop setting initial structure

Value

list with NewCond, Outputs and ClockStruct for n time-step

Examples

Solution(Weather, ClockStruct, InitialiseStruct)

TemperatureStress	<i>Calculate temperature stress coefficients</i>
-------------------	--

Description

Calculate temperature stress coefficients

Usage

TemperatureStress(Crop, Tmax, Tmin, GDD)

Arguments

Crop	Parameters for a given crop
Tmax	max temp for n time-step
Tmin	min temp for n time-step
GDD	Growing degree days

Value

Kst temperature stress a n time-step.

Examples

TemperatureStress(Crop, Tmax, Tmin, GDD)

Transpiration	<i>Calculate crop transpiration on current day</i>
---------------	--

Description

Calculate crop transpiration on current day

Usage

Transpiration(Soil, Crop, IrrMngt, InitCond, Et0, CO2, GrowingSeason)

Arguments

Soil	properties of soil
Crop	Parameters for a given crop
IrrMngt	Irrigation management
InitCond	Crop setting initial structure
Et0	Evapotranspiration
CO2	Infiltration
GrowingSeason	crop developmental stage

Value

list with NewCond, TrAct actual transpiration, TrPot_NS potential transpiration rate no water stress, TrPot0 potential transpiration rate, NewCond and IrrNet Initialise net irrigation, for a n time-step.

Examples

Transpiration(Soil, Crop, IrrMngt, InitCond, Et0, CO2, GrowingSeason)

UpdateCCxCDC	<i>Update CCx and CDC parameter valyes for rewatering in late season of an early declining canopy</i>
--------------	---

Description

Update CCx and CDC parameter valyes for rewatering in late season of an early declining canopy

Usage

UpdateCCxCDC(CCprev, CDC, CCx, dt)

Arguments

CCprev	Prev Canopy Cover
CDC	Canopy decline coefficient
CCx	Maximum canopy cover
dt	dt parameter

Value

list with CCXadj and CDCadj for a n time-step.

Examples

```
UpdateCCxCDC(CCprev, CDC, CCx, dt)
```

UpdateTime	<i>Update current time in model</i>
------------	-------------------------------------

Description

Update current time in model

Usage

```
UpdateTime(ClockStruct, InitialiseStruct)
```

Arguments

ClockStruct	crop calendar
InitialiseStruct	Crop setting initial structure

Value

list with InitialiseStruct and ClockStruct for a n time-step

Examples

```
UpdateTime(ClockStruct, InitialiseStruct)
```

WaterStress	<i>Calculate relative root zone water depletion for each stress type</i>
-------------	--

Description

Calculate relative root zone water depletion for each stress type

Usage

```
WaterStress(Crop, InitCond, Dr, TAW, Et0, beta)
```

Arguments

Crop	Parameters for a given crop
InitCond	Crop setting initial structure
Dr	Root zone water content at air dry
TAW	Total available water
Et0	Evapotranspiration
beta	beta

Value

water stress list with Exp, Sto, Sen, Pol and StoLin for a n time-step.

Examples

```
WaterStress(Crop,InitCond,Dr,TAW,Et0, beta)
```


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