Package 'weaana'

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Title Analysis the Weather Data

Type Package

Description Functions are collected to analyse weather data for agriculture purposes including to read weather records in multiple formats, calculate extreme climate index. Demonstration data are included the SILO daily climate data (licensed under CC BY 4.0, <https://www.longpaddock.qld.gov.au/silo/>).

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URL https://weaana.bangyou.me/, https://github.com/byzheng/weaana

BugReports https://github.com/byzheng/weaana/issues

Encoding UTF-8

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Depends R (>= 4.1.0)

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VignetteBuilder knitr

NeedsCompilation no

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Contents

`add_rh` *Add relative humidity to APSIM weather data*

Description

This function adds relative humidity data to APSIM weather records based on a standard weather file.

Usage

```
add_rh(apsim, standard, output = NULL, overwrite = FALSE)
```

Arguments

apsim	A character string specifying the path to the APSIM weather file.
standard	A character string specifying the path to the standard weather file containing relative humidity data.
output	A character string specifying the path to save the modified APSIM weather file with relative humidity data. If NULL, the function will not save the file.
overwrite	A logical value indicating whether to overwrite the output file if it already exists. Default is FALSE.

Value

A data frame containing the new weather records with relative humidity added.

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changeWeatherRecords *Change weather records*

Description

Change weather records

Change weather records

Usage

```
changeWeatherRecords(object, ...)

## S4 method for signature 'WeaAna'
changeWeatherRecords(object, ...)
```

Arguments

object	A WeaAna object.
...	New weather records

Value

A new WeaAna object with updated records

`climate_by_stages` *Summarise the climate variable by growth stages*

Description

Summarise the climate variable by growth stages

Usage

```
climate_by_stages(
  climates,
  sowing,
  emergence,
  heading = NULL,
  flowering = NULL,
  maturity,
  latitude
)
```

Arguments

`climates`	a data.frame for climate records
`sowing`	date. an vector of sowing date
`emergence`	numeric (days after sowing). an vector of emergence date
`heading`	numeric (days after sowing). an vector of heading date (optional. see details)
`flowering`	numeric (days after sowing). an vector of flowering time (optional. see details)
`maturity`	numeric (days after sowing). an vector of maturity time
`latitude`	latitude

Details

Define of growth stages

- S0: From start of year to emergence
- S1: From emergence to flowering time - 300Cd
- S2: From flowering time - 300Cd to flowering time + 100Cd
- S3: From flowering time + 100 Cd to flowering time + 600Cd
- S4: From flowering + 600Cd to maturity

Climate variables

- stage: defination of stages
- n: Number of days in each stage
- avgt: average temperature (C)

- sum.tt: total thermal time (Cd) with base temperature 0C
- avg.mint: average minimum temperature
- avg.maxt: average maximum temperature
- sum.rain: total rainfall
- avg.evap: average evapration
- avg.radn average radiation
- hot.days: number of hot days (daily maximum temperature is more than 30C)
- very.hot.days: number of very hot days (daily maximum temperature is more than 35C)
- frost.days: number of frost days (daily minimum temperature is less than 0C)
- hot.sum: total thermal time above 30C of hot days (daily maximum temperature is more than 30C)
- very.hot.sum: total thermal time above 35C of very hot days (daily maximum temperature is more than 35C)
- frost.sum: total thermal time below 0C of frost days (daily minimum temperature is less than 0C)
- vpd: vapour-pressure deficit
- te: transpiration efficiency
- bio.radn: bio.radn
- bio.water: bio.water
- bio.tt: bio.tt
- ptq: photothermal quotient
- avt.diffuse.radn: average diffuse radiation

Value

a data.frame for summarised climate variable by stages. See details for more information.

Examples

```
if (FALSE) {
   sowing <- rep(as.Date("1981-05-01"), 10)
   emergence <- rep(10, 10)
   heading <- NULL
   flowering <- runif(10) * 20 + 50
   maturity <- runif(10) * 20 + 100
   latitude <- -27
   res <- climate_by_stages(climates = climates,
                            sowing = sowing,
                            emergence = emergence,
                            heading = heading,
                            flowering = flowering,
                            maturity = maturity,
                            latitude = latitude)
}
```

convert2Records *Convert a data frame to weaana class*

Description

Convert a data frame to weaana class

Usage

```
convert2Records(infor, records)
```

Arguments

infor	A list or data frame of site information
records	A data frame will convert to records

Value

A new WeaAna object

createWeaAna *create WeaAna class*

Description

create WeaAna class

Usage

```
createWeaAna(mets)
```

Arguments

mets	A list contained information of weather records.

Value

A new WeaAna class

dayLength *The time elapsed in hours between the specified sun angle from 90 degree in am and pm. +ve above the horizon, -ve below the horizon.*

Description

The time elapsed in hours between the specified sun angle from 90 degree in am and pm. +ve above the horizon, -ve below the horizon.

Usage

```
dayLength(doy, lat, angle = -6)
```

Arguments

doy	day of year number
lat	latitude of site (deg)
angle	angle to measure time between, such as twilight (deg). angular distance between 90 deg and end of twilight - altitude of sun. +ve up, -ve down.

Value

day length in hours

diurnalT *Calculate the diurnal variation in air temperature with Parton and Logan, 1981*

Description

Calculate the diurnal variation in air temperature. Parton WJ, Logan JA (1981) A model for diurnal variation in soil and air temperature. Agricultural Meteorology, 23, 205?216. Codes copied from APSIM Utilities.cpp

Usage

```
diurnalT(maxt, mint, doy, hour, latitude, A = 1.5, B = 4, C = 1)
```

Arguments

maxt	maximum daily temperature
mint	minimum daily temperature
doy	day of year
hour	hour from 1 to 24
latitude	latitude in radials
A	is the time lag in temperature after noon
B	is coef that controls temperature decrease at night
C	is the time lag for min temperature after sunrise

Value

A vector with diurnal air temperature

Examples

```
diurnalT(maxt = 20, mint = 10, doy  = 1,
   hour = seq(from = 1, to = 23.99, by = 0.1),
   latitude = -10, A = 1.5, B = 4, C = 1)
```

---

dp_mint *Calculate Dew Point Temperature from Minimum Temperature and Relative Humidity*

Description

This function estimates the dew point temperature (C) using the Magnus-Tetens approximation, based on the minimum air temperature and relative humidity at that time.

Usage

```
dp_mint(mint, minrh)
```

Arguments

mint	Numeric. Minimum air temperature in degrees Celsius.
minrh	Numeric. Relative humidity (%) at minimum temperature.

Details

The dew point temperature is calculated using the following equations:

$$\gamma = \frac{a \cdot T}{b + T} + \ln\left(\frac{RH}{100}\right)$$

$$T_{dew} = \frac{b \cdot \gamma}{a - \gamma}$$

where $a = 17.62$ and $b = 243.12$.

Value

Numeric. Dew point temperature in degrees Celsius.

Examples

```
dp_mint(10, 80)  # Expected output: around 6.71
```

`getWeatherRecords` *Get all weather records by year range*

Description

Get all weather records by year range

Get all weather records by year range

Usage

```
getWeatherRecords(object, ...)

## S4 method for signature 'WeaAna'
getWeatherRecords(object, yrange = NULL, vars = "all", ...)
```

Arguments

`object`	A WeaAna object.
`...`	Other arguments
`yrange`	Year range.
`vars`	Variable

Value

A data frame with all weather records

Examples

```
library(weaana)
data( "WeatherRecordsDemo" )
getWeatherRecords( records, yrange = c( 2008, 2009 ) )
getWeatherRecords( records, yrange = c( 2008, 2009 ), length = 10 )
```

interpolationFunction *Return a y value from a linear interpolation function*

Description

Return a y value from a linear interpolation function

Usage

```
interpolationFunction(x, y, values, split = "\\s+")
```

Arguments

x	x
y	y
values	values
split	split

Value

The interpolated values

mov *Calculate the moving values*

Description

Calculate the moving values

Usage

```
mov(x, k = 10, shift = "centre", fun = "mean")
```

Arguments

x	A vector to calculate moving values
k	The moving windows
shift	if shift = "centre", then values are shifted to centre. if shift = "begin", then values are at begin of period. if shift = "end", then values are at end of period. The default value (centre) will be used if shift is other value.
fun	The method to calculate moving values. Curruntly, only "mean", "max", "min", and "sum" are supported. A NULL will be returned for any other values

Value

The moving value of vector x at moving windows k. A NULL will be returned for any unsupported fun

mov.avg *Use Calculate the moving average. For compatibility only.*

Description

Note that for n = odd, can average at central period. If n = even, must average at end of period and then shift values

Usage

```
mov.avg(x, k = 10, shift = "centre")
```

Arguments

x	A vector to calculate moving average
k	The moving windows
shift	if shift = "centre", then values are shifted to centre. if shift = "begin", then values are at begin of period. if shift = "end", then values are at end of period. The default value (centre) will be used if shift is other value.

Value

The moving average of vector x at moving windows n

mov.max *Calculate the moving maximum. For compatibility only.*

Description

Calculate the moving maximum. For compatibility only.

Usage

```
mov.max(x, k, shift = "centre")
```

Arguments

x	A vector to calculate moving maximum
k	The moving windows
shift	if shift = "centre", then values are shifted to centre. if shift = "begin", then values are at begin of period. if shift = "end", then values are at end of period. The default value (centre) will be used if shift is other value.

Value

The moving maximum of vector x at moving windows k

`mov.min` *Calculate the moving minimum. For compatibility only.*

Description

Calculate the moving minimum. For compatibility only.

Usage

```
mov.min(x, k, shift = "centre")
```

Arguments

`x`	A vector to calculate moving minimum
`k`	The moving windows
`shift`	if shift = "centre", then values are shifted to centre. if shift = "begin", then values are at begin of period. if shift = "end", then values are at end of period. The default value (centre) will be used if shift is other value.

Value

The moving minimum of vector x at moving windows k

`mov.sum` *Calculate the moving sum. For compatibility only.*

Description

Calculate the moving sum. For compatibility only.

Usage

```
mov.sum(x, k, shift = "centre")
```

Arguments

`x`	A vector to calculate moving sum
`k`	The moving windows
`shift`	if shift = "centre", then values are shifted to centre. if shift = "begin", then values are at begin of period. if shift = "end", then values are at end of period. The default value (centre) will be used if shift is other value.

Value

The moving sum of vector x at moving windows k

readWeatherRecords *Read weather records from a file list and/or a folder list*

Description

Read weather records from a file list and/or a folder list

Usage

```
readWeatherRecords(
  dataFiles = NULL,
  dataFolders = NULL,
  dataFormat = "APSIM",
  dataWeather = NULL,
  load.later = FALSE,
  ...
)
```

Arguments

dataFiles	A character vector to specify the path of weather data files.
dataFolders	A character vector to specify the path of weather data folders.
dataFormat	The format of weather data file.
dataWeather	A data.frame for existing data.
load.later	Whether load weather records now or later. "dataFroamt" should be One of "APSIM" and "RDATA".
...	Other arguments

Value

A WeaAna class which contains all weather data.

records *Demo weather records*

Description

Demo weather records

Usage

```
records
```

Format

An object of class WeaAna of length 1.

result-class *Define the class for statistics results*

Description

Define the class for statistics results

Slots

`name` Name of result

`type` Type of result

show,WeaAna-method *Show basic information of class WeaAna*

Description

Show the name, number, latitude, longitude of all weather stations.

Usage

```
## S4 method for signature 'WeaAna'
show(object)
```

Arguments

`object`	WeaAna objects

Examples

```
library(weaana)
data( "WeatherRecordsDemo" )
show( records )
records
```

`siteInfor` *Get site information*

Description

Get site information

Get site information

Get site information

Usage

```
siteInfor(object, ...)

## S4 method for signature 'WeaAna'
siteInfor(object, load.now = FALSE)

## S4 method for signature 'WeaAnaSite'
siteInfor(object, load.now = FALSE)
```

Arguments

`object`	A WeaAnaSite object.
`...`	Not used
`load.now`	Whether load site information

Value

Site information in the WeaAna object

Site information in the WeaAnaSite object

Examples

```
library(weaana)
data( "WeatherRecordsDemo" )
siteInfor( records )
siteInfor( records, load.now = TRUE )
```

sphericalDistance *Calculate the sphere distance*

Description

Calculate the sphere distance

Usage

```
sphericalDistance(lat1, lon1, lat2, lon2)
```

Arguments

lat1	Latitude
lon1	Longitude
lat2	Latitude
lon2	Longitude

Value

Distance in km

thermalTime *Calculate thermal time using cardinal temperatures*

Description

Calculate thermal time using cardinal temperatures

Usage

```
thermalTime(weather, x_temp, y_temp, method = NULL)
```

Arguments

weather	WeaAna object
x_temp	The cardinal temperatures
y_temp	The effective thermal time
method	The method to calculate thermal time. The default method is (maxt + mint) / 2 - base. The three hour temperature methods will be used if method = '3hr'

Value

A data.frame with three columns: year, day and thermalTime.

Examples

```
met_file <- system.file("extdata/WeatherRecordsDemo1.met", package = "weaana")
records <- readWeatherRecords(met_file)
x_temp <- c(0, 26, 34)
y_temp <- c(0, 26, 0)
res <- thermalTime(records, x_temp, y_temp)
head(res)
res <- thermalTime(records, x_temp, y_temp, method = "3hr")
head(res)
```

`thermalTimeDaily` *Calculate thermal time using cardinal temperatures*

Description

Calculate thermal time using cardinal temperatures

Usage

```
thermalTimeDaily(mint, maxt, x_temp, y_temp, method = NULL)
```

Arguments

`mint`	The minimum temperature
`maxt`	The maximum temperature
`x_temp`	The cardinal temperatures
`y_temp`	The effective thermal time
`method`	The method to calculate thermal time. The default method is (maxt + mint) / 2 - base. The three hour temperature methods will be usesd if method = '3hr'

Value

The thermal time.

Examples

```
mint <- c(0, 10)
maxt <- c(30, 40)
x_temp <- c(0, 20, 35)
y_temp <- c(0, 20, 0)
thermalTimeDaily(mint, maxt, x_temp, y_temp)
thermalTimeDaily(mint, maxt, x_temp, y_temp, method = '3hr')
```

thermalTimeHourly *Calculate thermal time using the hourly temperature (non daily temperature)*

Description

Calculate thermal time using the hourly temperature (non daily temperature)

Usage

```
thermalTimeHourly(timestamp, temperature, x_temp, y_temp)
```

Arguments

timestamp	The timestamp of weather records
temperature	The temperature
x_temp	The cardinal temperatures
y_temp	The effective thermal time

Value

A data frame with daily thermal time

Examples

```
met_file <- system.file("extdata/WeatherHourly.csv", package = "weaana")
hourly <- read.csv(met_file, as.is = TRUE)

hourly$timestamp <- as.POSIXct(hourly$timestamp, format = "%Y-%m-%dT%H:%M:%SZ")
x_temp <- c(0, 20, 35)
y_temp <- c(0, 20, 0)
thermalTimeHourly(hourly$timestamp, hourly$temperature, x_temp, y_temp)
```

ttest_ts *Significantly t-test with auto-correlation for time serial data*

Description

Method is presented by Santer et al. 2000

Usage

```
ttest_ts(y, slope = NULL)
```

Arguments

y	A vector of time serial data
slope	Whether export slope

Value

p values of t-test

---

tt_hourly_pp *Hourly Air Temperature Interpolation*

Description

Computes hourly estimates of air temperature (Ta) from daily Tmin, Tmax, and day length using the method of Goudriaan (1994). The function assumes a sinusoidal temperature variation during daylight hours and an exponential decay after sunset.

Usage

```
tt_hourly_pp(tmin, tmax, tmax_b, tmin_a, lat, doy)
```

Arguments

tmin	Numeric. Minimum temperature of the day (°C).
tmax	Numeric. Maximum temperature of the day (°C).
tmax_b	Numeric. Maximum temperature from the previous day (°C).
tmin_a	Numeric. Minimum temperature of the following day (°C).
lat	Numeric. Latitude of the location (degrees, -90 to 90).
doy	Integer. Day of the year (1 to 366).

Details

- **Daytime interpolation**: During sunlight hours, Ta is estimated using a sinusoidal curve fitted between Tmin and Tmax. - **Nighttime interpolation**: After sunset, Ta follows an exponential decline from the sunset temperature to the next morning's Tmin. - **Sunrise and Sunset Calculation**: - Sunrise hour: ‘hsrise = 12 - d/2‘ - Sunset hour: ‘hsset = 12 + d/2‘ - Tmax occurs at hour = 13.5.

If the Controlled Environment module is used for weather data, the function takes hourly values from that instead of computing them.

Value

A numeric vector of length 24 containing the estimated hourly air temperatures (°C).

References

Goudriaan, J. (1994). Advanced Methods for Calculating Radiation Models. Netherlands Journal of Agricultural Science, 42(4), 315-323.

Examples

```
tmin <- 10
tmax <- 20
tmax_b <- 21
tmin_a <- 11
lat <- -27
doy <- 10
hourly_temps <- tt_hourly_pp(tmin, tmax, tmax_b, tmin_a, lat, doy)
```

---

wcal *Calculate weather variables through function or a string formula.*

Description

There are two modes to use wcal, function mode if FUN is not null, and string formula mode if FUN is NULL.

Usage

```
wcal(object, ...)

## S4 method for signature 'WeaAna'
wcal(object, FUN = NULL, ..., var.args = NULL, var.name = NULL)
```

Arguments

object	A WeaAna objects.
...	Optional arguments to FUN in function mode. String formulas if FUN is NULL.
FUN	A function to be used which results should have the same length as original records.
var.args	Arguments of weather variable pass to FUN.
var.name	Variable name is used if FUN is not NULL.

Examples

```
library(weaana)
data( "records" )
# Daily mean temperature
wcal( records, avgt2 = "( maxt + mint ) / 2" )
# Moving average temperature
wcal( records, FUN = mov.avg, var.args = "avgt", k = 5, shift = "begin", var.name = "mov.avg" )
```

WeaAna-class *Define the class for multiple sites*

Description

Define the class for multiple sites

Slots

`num` total number of weather station

`records` A pointer vector to weather records of each site

`result` A pointer for all results name and type.

WeaAnaSite-class *Define the class of WeaAna*

Description

Define the class of WeaAna

Slots

`name` Name of weather station

`number` Station number of weather station

`latitude` Latitude of weather station

`longitude` Latitude of weather station

`tav` Annual average ambient temperature

`amp` Annual amplitude in mean monthly temperature

`marker` The extra marker for this site

`year` A vector of year of weather station

`day` A vector of day of weather station

`radn` A vector of radiation of weather station

`maxt` A vector of maximum temperature of weather station

`mint` A vector of minimum temperature of weather station

`evap` A vector of evaporation of weather station

`rain` A vector of rainfall of weather station

`vp` A vector of pressure atmosphere of weather station

`code` The 6 digit code indicates the source of the 6 data columns

`extra` A list of variables need to store

`res` All statistics results store in this slot

`figures` A list to store all plotted figures.

`file.path` The file path for this site.

`data.format` The data format for this site.

`load.later` Whether are records loaded laterly.

`writeWeatherRecords` *Write weather records into file*

Description

Write weather records into file

Write weather records into file

Usage

```
writeWeatherRecords(object, ...)

## S4 method for signature 'WeaAna'
writeWeatherRecords(object, file, cols = NULL)
```

Arguments

`object`	A WeaAna object.
`...`	Not used
`file`	Path of output file.
`cols`	Columns to export. All columns exported if NULL

Value

No return values

`[,WeaAna-method` *Getter to access the weather data at a specific position.*

Description

Getter to access the weather data at a specific position.

Usage

```
## S4 method for signature 'WeaAna'
x[i, j, drop]
```

Arguments

x	A WeaAna object.
i	the specific position which will access.
j	None use parameter.
drop	None use parameter.

Value

A WeaAnaSite object at the position i.

Examples

```
library(weaana)
data( "WeatherRecordsDemo" )
records[1]
records[1:2]
records[2:2]
```

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