Package ‘vineyard’

October 5, 2019

Type Package

Title Bud Break, Phenological and Yield Models for Vineyards

Version 0.1.0

Author D. Molitor [aut]
J. Junk [aut]
M. Sulis [aut]
J. A. Torres-Matallana [cre, aut]
S. Bhattacharya [ctb]
U. Leopold [ctb]
Luxembourg Institute of Science and Technology (LIST) [cph]

Maintainer J. A. Torres-Matallana <arturo.torres@list.lu>

Description Late frosts are a significant risk to grape production in frost-prone viticultural regions. Increasing air temperature because of climate change is likely to advance grape bud break and last frost events in spring. So far, it is unclear whether one trend will be more pronounced than the other, and hence, whether the risk of late frost damage will increase or decrease. The aim of this package is to provide tools for investigating e.g. the future frost risk in winegrowing regions by assessing the effect of simulated future climate conditions on the timing of bud break and last frost date. Late frost risk can be assessed by the implementation of phenological models for bud break of the grapevine.

License What license is it under?

Encoding UTF-8

LazyData true

RoxygenNote 6.1.1

R topics documented:

`cdd.lThresh` *Compute the cumulative degree days by the single (lower) temperature threshold*

Description

Implementation to compute the cumulative degree days by the single (lower) temperature threshold by Molitor et al., (2014).

Usage

```
cdd.lThresh(data, t.mean.col, a)
```

Arguments

`data`	input data in xts format.
`t.mean.col`	numeric, column position in data for the daily mean air temperature vector in Celsius degrees.
`a`	numeric, threshold temperature (in Celsius degrees) for vine growth.

Value

list per year for the input data plus an additional column with the cumulative degree days (in Celsius degrees) for vine growth. The output for each year is a "xts" time series object.

References

Daniel Molitor, Jürgen Junk, Danièle Evers, Lucien Hoffmann, and Marco Beyer (2014). A high-resolution cumulative degree day-based model to simulate phenological development of grapevine. Am. J. Enol. Vitic., (65:1):72–80.

`cdd.lThresh.phenology` *Cumulative degree days (cdd) by the single (lower) threshold algorithm for phenology*

Description

Implementation to compute the cumulative degree days (cdd) by the single (lower) threshold algorithm by Molitor et al. (2014) for phenology.

Usage

```
cdd.lThresh.phenology(cdd.lt, chs.mean)
```

Arguments

`cdd.lt`	list, cumulative degree days (in Celsius degrees) for vine growth in xts format per year as provided by "cdd.1Treshold" function.
`chs.mean`	numeric, mean cumulative heat sum for bud break (in Celsius degrees).

Value

the cumulative degree days (in Celsius degrees) for vine growth plus an additional column with the cumulative degree days (in Celsius degrees) for phenology.

References

Daniel Molitor, Jürgen Junk, Danièle Evers, Lucien Hoffmann, and Marco Beyer (2014). A high-resolution cumulative degree day-based model to simulate phenological development of grapevine. Am. J. Enol. Vitic., (65:1):72–80.

`cdd.luhThresh` *Compute cumulative degree days by the lower, upper and heat temperature thresholds*

Description

Implementation to compute cumulative degree days by the lower, upper and heat temperature thresholds by Molitor et al., (2014).

Usage

```
cdd.luhThresh(data, t.mean.col, a, b, c)
```

Arguments

`data`	input data in xts format.
`t.mean.col`	numeric, column position in data for the daily mean air temperature vector in Celsius degrees.
`a`	numeric, lower threshold temperature (in Celsius degrees) for vine growth.
`b`	numeric, upper threshold temperature (in Celsius degrees) for vine growth.
`c`	numeric, heat threshold temperature (in Celsius degrees) for vine growth.

Value

list per year for the input data plus an additional column with the cumulative degree days (in Celsius degrees) for vine growth. The output for each year is a "xts" time series object.

References

Daniel Molitor, Jürgen Junk, Danièle Evers, Lucien Hoffmann, and Marco Beyer (2014). A high-resolution cumulative degree day-based model to simulate phenological development of grapevine. Am. J. Enol. Vitic., (65:1):72–80.

`cdd.luhThresh.phenology` *Cumulative degree days (CDD) by the lower, upper and heat temperature thresholds for phenology*

Description

Implementation to compute the cumulative degree days by the lower, upper and heat temperature thresholds by Molitor et al. (2014) for phenology.

Usage

```
cdd.luhThresh.phenology(cdd.luht, chs.mean)
```

Arguments

`cdd.luht`	cumulative degree days (in Celsius degrees) for vine growth in xts format as provided by "DD.LUH.cumulative" function.
`chs.mean`	numeric, mean cumulative heat sum for bud break (in Celsius degrees).

Value

the cumulative degree days (in Celsius degrees) for vine growth plus an additional column with the cumulative degree days (in Celsius degrees) for phenology.

References

Daniel Molitor, Jürgen Junk, Danièle Evers, Lucien Hoffmann, and Marco Beyer (2014). A high-resolution cumulative degree day-based model to simulate phenological development of grapevine. Am. J. Enol. Vitic., (65:1):72–80.

`cdd.luThresh` *Compute the cumulative degree days by the double (lower and upper) temperature threshold*

Description

Implementation to compute the cumulative degree days by the double (lower and upper) temperature threshold by Molitor et al., (2014).

Usage

```
cdd.luThresh(data, t.mean.col, a, b)
```

Arguments

`data`	input data in xts format.
`t.mean.col`	numeric, column position in data for the daily mean air temperature vector in Celsius degrees.
`a`	numeric, lower threshold temperature (in Celsius degrees) for vine growth.
`b`	numeric, upper threshold temperature (in Celsius degrees) for vine growth.

Value

list per year for the input data plus an additional column with the cumulative degree days (in Celsius degrees) for vine growth. The output for each year is a "xts" time series object.

References

Daniel Molitor, Jürgen Junk, Danièle Evers, Lucien Hoffmann, and Marco Beyer (2014). A high-resolution cumulative degree day-based model to simulate phenological development of grapevine. Am. J. Enol. Vitic., (65:1):72–80.

cdd.luThresh.phenology — *Cumulative degree days (CDD) by the double (lower and upper) temperature thresholds for phenology*

Description

Implementation to compute the cumulative degree days by the double (lower and upper) temperature thresholds by Molitor et al. (2014) for phenology.

Usage

```
cdd.luThresh.phenology(cdd.lut, chs.mean)
```

Arguments

`cdd.lut`	list, cumulative degree days (in Celsius degrees) for vine growth in xts format per year as provided by the double threshold temperature ("cdd.double.threshold" function).
`chs.mean`	numeric, mean cumulative heat sum for bud break (in Celsius degrees).

Value

the cumulative degree days (in Celsius degrees) for vine growth plus an additional column with the cumulative degree days (in Celsius degrees) for phenology.

References

Daniel Molitor, Jürgen Junk, Danièle Evers, Lucien Hoffmann, and Marco Beyer (2014). A high-resolution cumulative degree day-based model to simulate phenological development of grapevine. Am. J. Enol. Vitic., (65:1):72–80.

cdd.single.triangle — *Cumulative degree days (CDD) by the single triangle algorithm*

Description

Implementation to compute the cumulative degree days by the single triangle algorithm by Nendel (2010).

Usage

```
cdd.single.triangle(data, t.zero, t.min.col, t.mean.col, t.max.col)
```

Arguments

`data`	input data in xts format.
`t.zero`	numeric, threshold temperature (in Celsius degrees) for vine growth.
`t.min.col`	numeric, column position in data for the daily minimum air temperature vector in Celsius degrees.
`t.mean.col`	numeric, column position in data for the daily mean air temperature vector in Celsius degrees.
`t.max.col`	numeric, column position in data for the daily maximum air temperature vector in Celsius degrees.
`start.date`	numeric, calculated optimum starting date in day of year.

Value

list per year for the input data plus an additional column with the cumulative degree days (in Celsius degrees) for vine growth. The output for each year is a "xts" time series object.

References

Nendel, Class (2010). Grapevine bud break prediction for cool winter climates. Int. J. Biometeorol., 54, 231–241.

`cdd.single.triangle.budbreak` *Cumulative degree days (CDD) by the single triangle algorithm for bud break*

Description

Implementation to compute the cumulative degree days by the single triangle algorithm by Nendel (2010) for bud break.

Usage

```
cdd.single.triangle.budbreak(cdd, start.date)
```

Arguments

`cdd`	cumulative degree days (in Celsius degrees) for vine growth in xts format as provided by "DD.single.triangle.cumulative" function.
`start.date`	numeric, calculated optimum starting date in day of year.

Value

the cumulative degree days (in Celsius degrees) for vine growth plus an additional column with the comulative degree days (in Celsius degrees) for bud break.

References

Nendel, Class (2010). Grapevine bud break prediction for cool winter climates. Int. J. Biometeorol., 54, 231–241.

`data_pik_observ` *Sample of meteorological data for the Moselle region in Luxembourg*

Description

A sample dataset containing time series of meteorological data for the Moselle region located in the Grand-Duchy of Luxembourg obtained by the Potsdam Institute for Climate Impact Research (PIK) in Germany. The data covers the period from 1961 to 2018 at daily time interval. The data is provided as a space-time full data frame (STFDF) object from "spacetime" package.

Usage

```
data(data_pik_observ)
```

Details

The spatial representation for the data corresponds to a SpatialPoints with coordinate reference system (CRS) EPSG:2169 - Luxembourg 1930 / Gauss - Projected.

Formal class 'STFDF' [package "spacetime"] with 4 slots
..@ data :'data.frame': 466048 obs. of 9 variables:
.. ..$ ta : num [1:466048] 1 1 1 1 1 1 1 1 1 1 ...
.. ..$ mo : num [1:466048] 1 1 1 1 1 1 1 1 1 1 ...
.. ..$ jahr : num [1:466048] 1961 1961 1961 1961 1961 ...
.. ..$ tmax : num [1:466048] 3.5 3.3 3 2.6 2.8 2.5 2 2.5 2.2 2 ...
.. ..$ tmit : num [1:466048] 2.3 2.2 1.7 1.3 1.6 1.1 0.5 1.5 1.1 0.7 ...
.. ..$ tmin : num [1:466048] 1.2 1 0.5 0 -0.1 -0.4 -0.9 -0.7 -0.9 -1.1 ...
.. ..$ prec : num [1:466048] 0 0 0 0 0 0 0 0 0 0 ...
.. ..$ ludr : num [1:466048] 984 982 978 973 980 ...
.. ..$ station_id: Factor w/ 22 levels "00809","00810",..: 1 2 3 4 5 6 7 8 9 10 ...
..@ sp :Formal class 'SpatialPoints' [package "sp"] with 3 slots
.. .. ..@ coords : num [1:22, 1:2] 90823 102882 115006 127122 100946 ...
.. ..- attr(*, "dimnames")=List of 2
.. ..$: NULL
.. ..$: chr [1:2] "x" "y"
.. .. ..@ bbox : num [1:2, 1:2] 81069 43466 127122 109652
.. ..- attr(*, "dimnames")=List of 2
.. ..$: chr [1:2] "x" "y"
.. ..$: chr [1:2] "min" "max"
.. .. ..@ proj4string:Formal class 'CRS' [package "sp"] with 1 slot
.. ..@ projargs: chr "+proj=tmerc +lat_0=49.8333333333334 +lon_0=6.16666666666667 +k=1 +x_0=80000 +y_0=100000 +ellps=intl +units=m +no_defs"
..@ time :An 'xts' object on 1961-01-01/2018-12-31 containing:

Data: int [1:21184, 1] 1 2 3 4 5 6 7 8 9 10 ...
- attr(*, "dimnames")=List of 2
..$: NULL..$: chr "timeIndex"
Indexed by objects of class: [POSIXct,POSIXt] TZ:
xts Attributes:
NULL
..@ endTime: POSIXct[1:21184], format: "1961-01-02" "1961-01-03" "1961-01-04" "1961-01-05" ...

Source

https://www.pik-potsdam.de/

Examples

```
#' Cohercion to data.frame
pik_observ.df <- as.data.frame(data_pik_observ)
head(pik_observ.df)

#' Cohercion to xts
pik_observ.xts <- xts(x = pik_observ.df, order.by = pik_observ.df$time)
head(pik_observ.xts)

#' plot stfdf object
year.ini <- which(index(data_pik_observ@time) == as.POSIXct("1973-06-01", format = "%Y-%m-%d"))
year.end <- which(index(data_pik_observ@time) == as.POSIXct("1973-06-30", format = "%Y-%m-%d"))

stplot(data.stfdf[, year.ini:year.end, "tmit"], scales=list(draw=TRUE))
stplot(data.stfdf[, year.ini:year.end, "tmit"], scales=list(draw=TRUE), mode = "ts")
```

`data_remich` *Sample of meteorological data for Remich station*

Description

A sample dataset containing time series of meteorological data for Remich station located in the Grand-Duchy of Luxembourg obtained by the Institut Viti-vinicole in Remich. The data covers the period from 1970 to 2017 at daily time interval. The data is providad as a space-time full data frame (STFDF) object from "spacetime" package.

Usage

```
data(data_remich)
```

Format

Formal class 'STFDF' [package "spacetime"] with 4 slots
..@ data :'data.frame': 17532 obs. of 8 variables:
.. ..$ Year : num [1:17532] 1970 1970 1970 1970 1970 1970 1970 1970 1970 1970 ...
.. ..$ Month : num [1:17532] 1 1 1 1 1 1 1 1 1 1 ...
.. ..$ Day : num [1:17532] 1 2 3 4 5 6 7 8 9 10 ...
.. ..$ DayYear : num [1:17532] 1 2 3 4 5 6 7 8 9 10 ...
.. ..$ T.max : num [1:17532] -3.5 -1 1 0.8 -0.1 -0.7 0 -0.3 3.6 4.3 ...
.. ..$ T.min : num [1:17532] -4.8 -6.5 -2.5 -0.4 -4.1 -4.5 -4.8 -5.4 -1.6 2.5 ...
.. ..$ T.mean : num [1:17532] -4.15 -3.75 -0.75 0.2 -2.1 -2.6 -2.4 -2.85 1 3.4 ...
.. ..$ Rainfall: num [1:17532] 0 0 2.7 0.8 4 3.2 0 0 1.8 5.8 ...
..@ sp :Formal class 'SpatialPointsDataFrame' [package "sp"] with 5 slots
.. .. ..@ data :'data.frame': 1 obs. of 4 variables:
.. ..$ id: Factor w/ 1 level "1": 1
.. ..$ x : num 6.35
.. ..$ y : num 49.5
.. ..$ z : Factor w/ 1 level "207": 1
.. .. ..@ coords.nrs : num(0)
.. .. ..@ coords : num [1, 1:2] 93626 67967
.. ..- attr(*, "dimnames")=List of 2
.. ..$: NULL
.. ..$: chr [1:2] "coords.x1" "coords.x2"
.. .. ..@ bbox : num [1:2, 1:2] 93626 67967 93626 67967
.. ..- attr(*, "dimnames")=List of 2
.. ..$: chr [1:2] "coords.x1" "coords.x2"
.. ..$: chr [1:2] "min" "max"
.. .. ..@ proj4string:Formal class 'CRS' [package "sp"] with 1 slot
.. ..@ projargs: chr "+proj=tmerc +lat_0=49.83333333333334 +lon_0=6.166666666666667 +k=1 +x_0=80000 +y_0=100000 +ellps=intl +units=m +no_defs"
..@ time :An 'xts' object on 1970-01-01/2017-12-31 containing:
Data: int [1:17532, 1] 1 2 3 4 5 6 7 8 9 10 ...
- attr(*, "dimnames")=List of 2
..$: NULL
..$: chr "timeIndex"
Indexed by objects of class: [POSIXct,POSIXt] TZ:
xts Attributes:
NULL
..@ endTime: POSIXct[1:17532], format: "1970-01-02" "1970-01-03" "1970-01-04" "1970-01-05" ...

Details

The spatial representation for the data corresponds to a SpatialPointsDataFrame with coordinate reference system (CRS) EPSG:2169 - Luxembourg 1930 / Gauss - Projected.

Source

https://agriculture.public.lu/de/weinbau-oenologie.html

Examples

```
#' Cohercion to data.frame
remich.df <- as.data.frame(data_remich)
head(remich.df)

#' Cohercion to xts
remich.xts <- xts(x = remich.df, order.by = remich.df$time)
head(remich.xts)
```

`dd.lThresh` *Compute degree days by the single (lower) temperature threshold*

Description

Implementation to compute degree days by the single (lower) temperature threshold by Molitor et al., (2014).

Usage

```
dd.lThresh(t.mean, a)
```

Arguments

`t.mean`	daily mean air temperature vector in Celsius degrees.
`a`	numeric, single (lower) threshold temperature (in Celsius degrees) for vine growth.

Value

a vector with the degree days.

References

Daniel Molitor, Jürgen Junk, Danièle Evers, Lucien Hoffmann, and Marco Beyer (2014). A high-resolution cumulative degree day-based model to simulate phenological development of grapevine. Am. J. Enol. Vitic., (65:1):72–80.

dd.luhThresh — *Compute the degree days by a lower, upper and heat temperature thresholds*

Description

Implementation to compute the degree days by a lower, upper and heat temperature thresholds by Molitor et al., (2014).

Usage

```
dd.luhThresh(t.mean, a, b, c)
```

Arguments

`t.mean`	daily mean air temperature vector in Celsius degrees.
`a`	numeric, lower threshold temperature (in Celsius degrees) for vine growth.
`b`	numeric, upper threshold temperature (in Celsius degrees) for vine growth.
`c`	numeric, heat threshold temperature (in Celsius degrees) for vine growth.

Value

a vector with the degree days (in Celsius degrees) for vine growth.

References

Daniel Molitor, Jürgen Junk, Danièle Evers, Lucien Hoffmann, and Marco Beyer (2014). A high-resolution cumulative degree day-based model to simulate phenological development of grapevine. Am. J. Enol. Vitic., (65:1):72–80.

dd.luThresh — *Compute the degree days by the double (lower and upper) temperature thresholds*

Description

Implementation to compute the degree days by the double (lower and upper) temperature thresholds by Molitor et al., (2014).

Usage

```
dd.luThresh(t.mean, a, b)
```

Arguments

`t.mean`	vector, daily mean air temperature in Celsius degrees.
`a`	numeric, lower threshold temperature (in Celsius degrees) for vine growth.
`b`	numeric, upper threshold temperature (in Celsius degrees) for vine growth.

Value

a vector with the degree days (in Celsius degrees) for vine growth.

References

Daniel Molitor, Jürgen Junk, Danièle Evers, Lucien Hoffmann, and Marco Beyer (2014). A high-resolution cumulative degree day-based model to simulate phenological development of grapevine. Am. J. Enol. Vitic., (65:1):72–80.

`dd.single.triangle` *Degree days by the single triangle algorithm*

Description

Implementation to compute the degree days by the single triangle algorithm by Nendel (2010).

Usage

```
dd.single.triangle(t.zero, t.min, t.mean, t.max)
```

Arguments

`t.zero`	numeric, threshold temperature (in Celsius degrees) for vine growth.
`t.min`	daily minimum air temperature vector in Celsius degrees.
`t.max`	daily maximum air temperature vector in Celsius degrees.

Value

a vector with the degree-days (in Celsius degrees) for vine growth.

References

Nendel, Class (2010). Grapevine bud break prediction for cool winter climates. Int. J. Biometeorol., 54, 231–241.

`fill.na` *Fill NA data in time series*

Description

Fill NA data in time series

Usage

```
fill.na(x)
```

Arguments

`x`	the input time series as xts object.

Value

a time series with the NAs replaced by data according to the na.locf zoo function.

`GrowthStage_CDD` *Cumulative degree days and growth stages*

Description

A sample dataset containing the cumulative degree days (CDD) with optimized lower, upper, and heat threshold triplets (5, 20, 22°C) per growth stages according to Table 4 from Molitor et al. (2014).

References

Daniel Molitor, Jürgen Junk, Danièle Evers, Lucien Hoffmann, and Marco Beyer. A high-resolution cumulative degree day-based model to simulate phenological development of grapevine. Am. J. Enol. Vitic., (65:1):72–80, 2014.

`id.na` *Find indexes for NA data in time series*

Description

Find indexes for NA data in time series

Usage

```
id.na(x)
```

Arguments

`x`	the input time series as xts object.

Value

a vector with the index for NA data in the time series.

`phenology.stages` *Compute phenological stages*

Description

Implementation to compute phenological stages by Molitor et al., (2014).

Usage

```
phenology.stages(cdd.phen, ref.data, stage)
```

Arguments

`cdd.phen`	list, cumulative degree days (in Celsius degrees) for vine growth in xts format as provided by any of the functions "cdd.1Tresh.phenology" or "cdd.2Tresh.phenology" or "cdd.3Tresh.phenology".
`ref.data`	data.frame, reference dataset to define the phenological stages e.g. "Gowth-Stage_CDD" dataset.
`stage`	vector, growth stage(s) for which the phenology should be computed. One or more out of the 27 stages that range from 11 (First leaf unfolded and spread away from shoot) to 89 (Berries ripe for harvest) according to Molitor et al. (2014).

Value

list per year, with each list containing a data.frame with the phenological stages for vine growth.

References

Daniel Molitor, Jürgen Junk, Danièle Evers, Lucien Hoffmann, and Marco Beyer (2014). A high-resolution cumulative degree day-based model to simulate phenological development of grapevine. Am. J. Enol. Vitic., (65:1):72–80.

---

plot.na — *Plot NA data in time series*

Description

Plot NA data in time series

Usage

```
plot.na(x, ids.na)
```

Arguments

`x`	the input time series as xts object.
`ids.na`	the vector which contains indexes for NA data as provided by the Id.na function.

Value

plots with the NAs highlighted.

---

raw2xts — *Raw data to xts object*

Description

Raw data to xts object

Usage

```
raw2xts(data, year.name, month.name, day.name)
```

Arguments

`data`	the dataframe to convert to xts time series.
`year.name`	the column name for the variable year.
`month.name`	the column name for the variable month.
`day.name`	the column name for the variable day.

Value

the xts object for the input dataframe.

Index