

# Package ‘vineyard’

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**Type** Package

**Title** Bud Break, Phenological and Yield Models for Vineyards

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**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

**Imports** xts,  
zoo

**Suggests** knitr,  
rmarkdown,  
sp,  
spacetime

**VignetteBuilder** knitr

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cdd.lThresh	<i>Compute the cumulative degree days by the single (lower) temperature threshold</i>
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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.

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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.lThreshold" 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	<i>Compute cumulative degree days by the lower, upper and heat temperature thresholds</i>
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### 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	<i>Cumulative degree days (CDD) by the lower, upper and heat temperature thresholds for phenology</i>
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### 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.luThresh.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.

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cdd.luThresh	<i>Compute the cumulative degree days by the double (lower and upper) temperature threshold</i>
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**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	<i>Cumulative degree days (CDD) by the single triangle algorithm</i>
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---

**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.

**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.

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cdd.single.triangle.budbreak	<i>Cumulative degree days (CDD) by the single triangle algorithm for bud break</i>
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**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 cumulative 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.

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data\_boundary\_grevenmacher

*A 'sp' object for the Grevenmacher administrative boundaries*

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**Description**

A dataset containing a 'sp' object for the administrative boundaries of the District of Grevenmacher in the Grand-Duchy of Luxembourg. It comprises the Commune and Canton levels as provided by the Luxembourgish Data Platform. The data is provided as a SpatialPolygonsDataFrame from "sp" package.

**Usage**

```
data(data_boundary_grevenmacher)
```

**Format**

```
Formal class 'SpatialPolygonsDataFrame' [package "sp"] with 5 slots
..@ data :'data.frame': 23 obs. of 4 variables:
.. ..$ COMMUNE : Factor w/ 23 levels "Beaufort","Bech",...: 14 16 1 18 9 12 8 10 4 2 ...
.. ..$ CANTON : Factor w/ 3 levels "Echternach","Grevenmacher",...: 2 3 1 1 1 2 3 2 2 1 ...
.. ..$ DISTRICT: Factor w/ 1 level "Grevenmacher": 1 1 1 1 1 1 1 1 1 1 ...
.. ..$ LAU2 : Factor w/ 23 levels "1001","1002",...: 13 19 1 6 5 12 17 10 8 2 ...
..@ polygons :List of 23
.. ..$:Formal class 'Polygons' [package "sp"] with 5 slots
.. .. ..@ Polygons :List of 1
.. .. .. ..$:Formal class 'Polygon' [package "sp"] with 5 slots
.. .. .. ..@ labpt : num [1:2] 97715 87463
```



```

.. .. ..@ area : num 27853866
.. .. ..@ hole : logi FALSE
.. .. ..@ ringDir: int 1
#' .. .. ..@ coords : num [1:1611, 1:2] 96023 96027 96037 96070 96078 ...
.. .. ..@ plotOrder: int 1
.. .. ..@ labpt : num [1:2] 97715 87463
.. .. ..@ ID : chr "0"
.. .. ..@ area : num 27853866
.. ..$ :Formal class 'Polygons' [package "sp"] with 5 slots
.. .. ..@ Polygons :List of 1
.. .. ..$ :Formal class 'Polygon' [package "sp"] with 5 slots
.. .. .. ..@ labpt : num [1:2] 88254 64603
.. .. .. ..@ area : num 13591512
.. .. .. ..@ hole : logi FALSE
.. .. .. ..@ ringDir: int 1
.. .. .. ..@ coords : num [1:1012, 1:2] 89679 89677 89674 89673 89673 ...
.. .. .. ..@ plotOrder: int 1
.. .. .. ..@ labpt : num [1:2] 88254 64603
.. .. .. ..@ ID : chr "1"
.. .. .. ..@ area : num 13591512
.. ..$ :Formal class 'Polygons' [package "sp"] with 5 slots
.. .. ..@ Polygons :List of 1
.. .. ..[list output truncated]

```

## Details

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

## Source

<https://data.public.lu/fr/datasets/limites-administratives-du-grand-duche-de-luxembourg/>

## Examples

```

data(data_boundary_grevenmacher)
str(data_boundary_grevenmacher)

#' plot stfdd object
plot(data_boundary_grevenmacher)

```

## 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)
```

## Format

```
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 [1:2, 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=49.83333333333334 +lon_0=6.166666666666667
+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"
...
```

## Details

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

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

#' plot stfddf 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_pik_observ[, year.ini:year.end, "tmit"], scales=list(draw=TRUE))
stplot(data_pik_observ[, 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 provided 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
library(xts)

```

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

---

data_vineyards2018	<i>A 'sp' object for the vineyards along the Mosel in Luxemburg in 2018</i>
--------------------	---

---

## Description

A dataset containing a 'sp' object for the vineyards along the Mosel in the Grand-Duchy of Luxembourg in 2018. The data is provided by the Luxembourgish Data Platform, and provided as a SpatialPolygonsDataFrame from "sp" package.

## Usage

```
data(data_vineyards2018)
```

## Format

```
Formal class 'SpatialPolygonsDataFrame' [package "sp"] with 5 slots
..@ data :'data.frame': 4966 obs. of 7 variables:
.. ..$ Weinbergsn: Factor w/ 4950 levels "1","10005","10007",...: 1359 4035 3194 2950 2952 1083
2849 2871 2874 2951 ...
.. ..$ CODE_ELEM : Factor w/ 1 level "V": 1 1 1 1 1 1 1 1 1 1 ...
.. ..$ CODE_COM : Factor w/ 14 levels "?","022","023",...: 12 4 14 6 12 12 14 14 14 14 ...
.. ..$ CODE_SECT : Factor w/ 8 levels "A","b","B","c",...: 1 7 8 7 3 3 7 7 7 7 ...
.. ..$ Shape_Leng: num [1:4966] 164 247 231 311 282 ...
.. ..$ Shape_Le_1: num [1:4966] 164 247 231 311 282 ...
.. ..$ Shape_Area: num [1:4966] 504 3773 3000 6016 2686 ...
..@ polygons :List of 4966
.. ..$ :Formal class 'Polygons' [package "sp"] with 5 slots
.. .. ..@ Polygons :List of 1
.. .. .. ..$ :Formal class 'Polygon' [package "sp"] with 5 slots
.. .. .. .. ..@ labpt : num [1:2] 93823 71477
.. .. .. .. ..@ area : num 504
.. .. .. .. ..@ hole : logi FALSE
.. .. .. .. ..@ ringDir: int 1
.. .. .. .. ..@ coords : num [1:6, 1:2] 93793 93797 93853 93851 93849 ...
.. .. ..@ plotOrder: int 1
.. .. .. ..@ labpt : num [1:2] 93823 71477
.. .. .. ..@ ID : chr "0"
.. .. .. ..@ area : num 504
.. .. ..$ :Formal class 'Polygons' [package "sp"] with 5 slots
.. .. .. ..@ Polygons :List of 1
.. .. .. .. ..$ :Formal class 'Polygon' [package "sp"] with 5 slots
.. .. .. .. ..@ labpt : num [1:2] 96817 77073
.. .. .. .. ..@ area : num 3773
```

```

.. .. ..@ hole : logi FALSE
.. .. ..@ ringDir: int 1
.. .. ..@ coords : num [1:8, 1:2] 96857 96848 96839 96827 96777 ...
.. .. ..@ plotOrder: int 1
.. .. ..@ labpt : num [1:2] 96817 77073
.. .. ..@ ID : chr "1"
.. .. ..@ area : num 3773
.. .. .$ :Formal class 'Polygons' [package "sp"] with 5 slots
.. .. ..@ Polygons :List of 1
.. .. ..[list output truncated]

```

### Details

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

### Source

<https://data.public.lu/fr/datasets/vineyards/>

### Examples

```

data(data_vineyards2018)
str(data_vineyards2018, list.len = 15)

#' plot sp object
library(sp)
spplot(data_vineyards2018, zcol="Weinbergsn", col = "Brown", scales = list(draw = TRUE),
        colorkey = FALSE)

```

---

data_water_surface	<i>A 'sp' object for the water surfaces in Grevenmacher</i>
--------------------	---

---

### Description

A dataset containing a 'sp' object for the water surfaces in the District of Grevenmacher in the Grand-Duchy of Luxembourg. The dataset contains stretches from the Moselle (Mosel) and the Sûre rivers. The data is provided by the Luxembourgish Data Platform, and provided as a SpatialPolygonsDataFrame from "sp" package.

### Usage

```
data(data_water_surface)
```

## Format

```
Formal class 'SpatialPolygonsDataFrame' [package "sp"] with 5 slots
..@ data :'data.frame': 1373 obs. of 5 variables:
.. ..$ cat : int [1:1373] 1 2 3 4 5 6 7 8 9 10 ...
.. ..$ id : int [1:1373] 1 1 1 1 1 1 1 1 1 1 ...
.. ..$ ID_2 : Factor w/ 1353 levels "2?443?282","2?443?944",...: 2 4 9 16 19 35 39 45 51 56 ...
.. ..$ NATURE : int [1:1373] 3 3 3 3 3 3 3 3 3 3 ...
.. ..$ TOPONYME: Factor w/ 4 levels "Bassin d'?puration",...: NA NA NA NA NA NA NA NA NA NA ...
..@ polygons :List of 1373
.. ..$ :Formal class 'Polygons' [package "sp"] with 5 slots
.. .. ..@ Polygons :List of 1
.. .. .. ..$ :Formal class 'Polygon' [package "sp"] with 5 slots
.. .. .. .. ..@ labpt : num [1:2] 93462 66333
.. .. .. .. ..@ area : num 145
.. .. .. .. ..@ hole : logi FALSE
.. .. .. .. ..@ ringDir: int 1
.. .. .. .. ..@ ringDir: int 1
.. .. .. .. ..@ coords : num [1:11, 1:2] 93468 93468 93466 93464 93462 ...
.. .. ..@ plotOrder: int 1
.. .. ..@ labpt : num [1:2] 93462 66333
.. .. ..@ ID : chr "0"
.. .. ..@ area : num 145
.. ..$ :Formal class 'Polygons' [package "sp"] with 5 slots
.. .. ..@ Polygons :List of 1
.. .. ..[list output truncated]
```

## Details

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

The dataset identifies natural or artificial water surface, permanent or not. The field NATURE is defined as: 0 = stream surface; 1 = stagnant water surface; 2 = wet zone; 3 = basin; 4 = purification basin; 5 = pool; 6 = fish farming.

The selection criteria for defining the NATURE field is:

0: surface of stream of permanent flow. Minimum width 3.5 m.

1: permanent water surface without flow: lake, pond, pond whose smallest dimension is greater than 20 m. Dams are treated in this class and are updated if their area has increased 50%.

2: wetland area greater than 2 Ha, marsh, aquatic vegetation.

3: open basin. Treatment plant basins, swimming pools or fish farms are treated with a particular attribute value. Most small dimension must be greater than 10 m and the outline masonry.

4: sewage treatment plant basin, the smallest dimension of which must be greater than 10 m and the masonry outline.

5: swimming pool whose smallest dimension must be greater than 10 m.

6: fish pond with the smallest dimension greater than 10 m and the masonry outline.

Source

[https://data.public.lu/en/datasets/bd-l-tc-surface-deau/#\\_](https://data.public.lu/en/datasets/bd-l-tc-surface-deau/#_)

Examples

```
data(data_water_surface)
str(data_water_surface, list.len = 15)

#' plot stfdf object
library(sp)
splot(data_water_surface, zcol="id", scales = list(draw = TRUE),
       colorkey = FALSE)
```

---

dd.lThresh	<i>Compute degree days by the single (lower) temperature threshold</i>
------------	--

---

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	<i>Compute the degree days by a lower, upper and heat temperature thresholds</i>
--------------	--

---

### 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	<i>Compute the degree days by the double (lower and upper) temperature thresholds</i>
-------------	---

---

### 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**

<code>t.mean</code>	vector, daily mean air temperature in Celsius degrees.
<code>a</code>	numeric, lower threshold temperature (in Celsius degrees) for vine growth.
<code>b</code>	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.

---

<code>dd.single.triangle</code>	<i>Degree days by the single triangle algorithm</i>
---------------------------------	---

---

**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**

<code>t.zero</code>	numeric, threshold temperature (in Celsius degrees) for vine growth.
<code>t.min</code>	daily minimum air temperature vector in Celsius degrees.
<code>t.mean</code>	daily mean air temperature vector in Celsius degrees.
<code>t.max</code>	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	<i>Fill NA data in time series</i>
---------	------------------------------------

---

### 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	<i>Cumulative degree days and growth stages</i>
-----------------	---

---

### 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	<i>Find indexes for NA data in time series</i>
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---

**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	<i>Compute phenological stages</i>
------------------	------------------------------------

---

**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. "Growth-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	<i>Plot NA data in time series</i>
---------	------------------------------------

---

## 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	<i>Raw data to xts object</i>
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---

## 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.

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