Indecis

Sectorial Climate Services

Integrated approach for the **d**evelopment across **E**urope of user oriented **c**limate **i**ndicators for GFCS high-priority **s**ectors: Agriculture, disaster risk reduction, energy, health, water and tourism

Work Package 4

Deliverable 4.3

Release of the Software Suite for indices Calculation

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Package 'ClimInd'

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Type Package

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Title Climate Indices

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Depends R (>= 2.10), SPEI, chron, weathermetrics

Description Computes 138 standard climate indices at monthly, seasonal and annual resolution. These indices were selected, based on their direct and significant impacts on target sectors, after a thorough review of the literature in the field of extreme weather events and natural hazards. Overall, the selected indices characterize different aspects of the frequency, intensity and duration of extreme events, and are derived from a broad set of climatic variables, including surface air temperature, precipitation, relative humidity, wind speed, cloudiness, solar radiation, and snow cover. The 138 indices have been classified as follow: Temperature based indices (42), Precipitation based indices (22), Bioclimatic indices (21), Wind-based indices (5), Aridity/ continentality indices (10), Snow-based indices (13), Cloud/radiation based indices (6), Drought indices (8), Fire indices (5), Tourism indices (5).

License GPL (>= 3)

URL https://gitlab.com/indecis-eu/indecis

LazyLoad yes

Encoding UTF-8

Suggests MASS, rmarkdown, testthat

NeedsCompilation no

RoxygenNote 6.1.1

ByteCompile true

Collate 'ClimInd.R' 'ClimIndNews.R' 'custom_functions.R' 'data.R' 'ffdi.R' 'fwi1D.R' 'penman_fao_dia.R' 'nesterovIndex.R' 'macArthurFFDI.R' 'kbdindex.R' 'indecis_indices_functions.R' 'indecis_indices.R' 'indecis.R'

Repository CRAN

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R topics documented:

ClimInd-package *ClimInd: Climate Indices*

Description

Computes 138 standard climate indices at monthly, seasonal and annual resolution. These indices were selected, based on their direct and significant impacts on target sectors, after a thorough review of the literature in the field of extreme weather events and natural hazards. Overall, the selected indices characterize different aspects of the frequency, intensity and duration of extreme events, and are derived from a broad set of climatic variables, including surface air temperature, precipitation, relative humidity, wind speed, cloudiness, solar radiation, and snow cover. The 138 indices have been classified as follow: Temperature based indices (42), Precipitation based indices (22), Bioclimatic indices (21), Wind-based indices (5), Aridity/ continentality indices (10), Snow-based indices (13), Cloud/radiation based indices (6), Drought indices (8), Fire indices (5), Tourism indices (5).

Details

Info

See Also

Useful links:

- https://gitlab.com/indecis-eu/indecis

aci *Atmospheric Clarity Index*

Description

Ratio between solar radiation at surface and solar radiation at TOA (alt top of the atmosphere)

Usage

```
aci(data, toa, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	net radiation
toa	solar radiation at TOA
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

ACI

Examples

```
data(data_all)
aci(data = data_all$radiation, toa = data_all$radiationtoa)
```

`asd` *Average snow depth*

Description

Average snow depth

Usage

```
asd(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

`data`	snow depth
`data_names`	names of each period of time
`time.scale`	month, season or year
`na.rm`	logical. Should missing values (including NaN) be removed?

Value

average snow depth

Examples

```
data(data_all)
asd(data = data_all$snowdepththickness)
```

`at` *Apparent temperature*

Description

Index of the percived temperature.

Usage

```
at(taverage, w, vapor, data_names = NULL, time.scale = YEAR,
  na.rm = FALSE)
```

Arguments

`taverage`	medium temperature
`w`	average wind
`vapor`	water vapour pressure
`data_names`	names of each period of time
`time.scale`	month, season or year
`na.rm`	logical. Should missing values (including NaN) be removed?

Value

AT

Formula

$$AT = TG + 0.33e - 0.70v - 4.00$$

TG = air temperature in Celsius ; v = wind speed in m/s; e= water vapour pressure in hPa

Examples

```
data(data_all)
at(taverage = data_all$tg, w = data_all$wind, vapor = data_all$VAPOUR)
```

`bi` *Budyko Index*

Description

Budyko Index is based on characteristics of the surface heat and water balance.

Usage

```
bi(data, pr, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

`data`	net radiation, surface solar radiation downwards, J/m2
`pr`	precipitation
`data_names`	names of each period of time
`na.rm`	logical. Should missing values (including NaN) be removed?
`...`	...

Value

Budyko Index

Formula

$$BI = 100\frac{Rn}{L * P}$$

Rn= annual net radiation, P = annual precipitation, L = latent heat of vaporization for water

References

Budyko M.I. The Heat Balance of the Earth's Surface U.S. Department of Commerce, Washington D.C (1958) 259 pp., translated by N.A. Stepanova

Examples

```
data(data_all)
bi(data = data_all$radiation, pr = data_all$rr)
```

bio10 *TG of warmest quarter*

Description

TG of the warmest quarter of the year

Usage

```
bio10(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	medium temperature
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

BIO10

References

Hijmans RJ, Cameron SE, Parra JL, Jones PG, Jarvis A (2005) Very high resolution interpolated climate surfaces for global land areas. Int J Climatol 25:1965–1978. doi: 10.1002/joc.1276. http://www.worldclim.org/bioclim

Examples

```
data(data_all)
bio10(data = data_all$tg)
```

bio11 *TG of coldest quarter*

Description

TG of coldest quarter of the year

Usage

```
bio11(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	medium temperature
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

BIO11

References

Hijmans RJ, Cameron SE, Parra JL, Jones PG, Jarvis A (2005) Very high resolution interpolated climate surfaces for global land areas. Int J Climatol 25:1965–1978. doi: 10.1002/joc.1276. http://www.worldclim.org/bioclim

Examples

```
data(data_all)
bio11(data = data_all$tg)
```

---

bio13 *Precipitation of wettest month*

Description

Total precipitation of the wettest month of the year

Usage

```
bio13(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	precipitation
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

BIO13

References

Hijmans RJ, Cameron SE, Parra JL, Jones PG, Jarvis A (2005) Very high resolution interpolated climate surfaces for global land areas. Int J Climatol 25:1965–1978. doi: 10.1002/joc.1276. http://www.worldclim.org/bioclim

Examples

```
data(data_all)
bio13(data = data_all$rr)
```

`bio14` *Precipitation of driest month*

Description

Total precipitation of the driest month of the year

Usage

```
bio14(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

`data`	precipitation
`data_names`	names of each period of time
`na.rm`	logical. Should missing values (including NaN) be removed?
`...`	...

Value

BIO14

References

Hijmans RJ, Cameron SE, Parra JL, Jones PG, Jarvis A (2005) Very high resolution interpolated climate surfaces for global land areas. Int J Climatol 25:1965–1978. doi: 10.1002/joc.1276. http://www.worldclim.org/bioclim

Examples

```
data(data_all)
bio14(data = data_all$rr)
```

bio15 *Precipitation coefficient of variation*

Description

The coefficient of variation is a measure of the variation in monthly precipitation totals over the course of the year. This index is the ratio of the standard deviation of the monthly total precipitation to the mean monthly total precipitation and is expressed as a percentage.

Usage

```
bio15(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	precipitation
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

BIO15

References

Hijmans RJ, Cameron SE, Parra JL, Jones PG, Jarvis A (2005) Very high resolution interpolated climate surfaces for global land areas. Int J Climatol 25:1965–1978. doi: 10.1002/joc.1276. http://www.worldclim.org/bioclim This is a measure of the variation in monthly precipitation totals over the course of the year. This index is the ratio of the standard deviation of the monthly total precipitation to the mean monthly total precipitation (also known as the coefficient of variation) and is expressed as a percentage.

Examples

```
data(data_all)
bio15(data = data_all$rr)
```

bio16 *Precipitation wettest quarter*

Description

Precipitation of the wettest quarter of the year

Usage

```
bio16(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	precipitation
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

BIO16

References

Hijmans RJ, Cameron SE, Parra JL, Jones PG, Jarvis A (2005) Very high resolution interpolated climate surfaces for global land areas. Int J Climatol 25:1965–1978. doi: 10.1002/joc.1276. http://www.worldclim.org/bioclim

Examples

```
data(data_all)
bio16(data = data_all$rr, na.rm = TRUE)
```

bio17 *Precipitation of Driest Quarter*

Description

Precipitation of the driest quarter of the year

Usage

```
bio17(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	precipitation
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

BIO17

References

Hijmans RJ, Cameron SE, Parra JL, Jones PG, Jarvis A (2005) Very high resolution interpolated climate surfaces for global land areas. Int J Climatol 25:1965–1978. doi: 10.1002/joc.1276. http://www.worldclim.org/bioclim

Examples

```
data(data_all)
bio17(data = data_all$rr)
```

---

bio18 *Precipitation warmest quarter*

Description

Precipitation of the warmest quarter of the year

Usage

```
bio18(pr, taverage, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

pr	precipitation
taverage	medium temperature
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

BIO18

References

Hijmans RJ, Cameron SE, Parra JL, Jones PG, Jarvis A (2005) Very high resolution interpolated climate surfaces for global land areas. Int J Climatol 25:1965–1978. doi: 10.1002/joc.1276. http://www.worldclim.org/bioclim

Examples

```
data(data_all)
bio18(pr=data_all$rr, taverage=data_all$tg)
```

---

bio19 *Precipitation coldest quarter*

Description

Precipitation of the coldest quarter of the year

Usage

```
bio19(pr, taverage, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

pr	precipitation
taverage	medium temperature
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

BIO19

References

Hijmans RJ, Cameron SE, Parra JL, Jones PG, Jarvis A (2005) Very high resolution interpolated climate surfaces for global land areas. Int J Climatol 25:1965–1978. doi: 10.1002/joc.1276. http://www.worldclim.org/bioclim

Examples

```
data(data_all)
bio19(pr=data_all$rr, taverage=data_all$tg)
```

bio20 *Mean radiation*

Description

Mean radiation (W m-2)

Usage

```
bio20(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	radiation en w/m2
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

BIO20

References

Kriticos, D.J., Webber, B.L., Leriche, A., Ota, N., Macadam, I., Bathols, J. and Scott, J.K. (2012) CliMond: global high-resolution historical and future scenario climate surfaces for bioclimatic modelling. Methods in Ecology and Evolution, 3, 53-64. http://dx.doi.org/10.1111/j.2041-210X.2011.00134.x

Examples

```
data(data_all)
bio20(data = data_all$radiation_w)
```

bio4 *Temperature seasonality*

Description

TG standard deviation *100

Usage

```
bio4(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	medium temperature
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

BIO4

References

Hijmans RJ, Cameron SE, Parra JL, Jones PG, Jarvis A (2005) Very high resolution interpolated climate surfaces for global land areas. Int J Climatol 25:1965–1978. doi: 10.1002/joc.1276. http://www.worldclim.org/bioclim

Examples

```
data(data_all)
bio4(data = data_all$tg)
```

---

bio5 *TX warmest month*

Description

TX of the warmest month of the year

Usage

```
bio5(data, tmax, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	mean temperature
tmax	maximum temperature
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

BIO5

References

Hijmans RJ, Cameron SE, Parra JL, Jones PG, Jarvis A (2005) Very high resolution interpolated climate surfaces for global land areas. Int J Climatol 25:1965–1978. doi: 10.1002/joc.1276. http://www.worldclim.org/bioclim

Examples

```
data(data_all)
bio5(data = data_all$tg, tmax = data_all$tx)
```

---

bio6 *TN of coldest month*

Description

TN of the coldest month of the year

Usage

```
bio6(data, tmin, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	mean temperature
tmin	minimum temperature
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

BIO6

References

Hijmans RJ, Cameron SE, Parra JL, Jones PG, Jarvis A (2005) Very high resolution interpolated climate surfaces for global land areas. Int J Climatol 25:1965–1978. doi: 10.1002/joc.1276. http://www.worldclim.org/bioclim

Examples

```
data(data_all)
bio6(data = data_all$tg, tmin = data_all$tn)
```

bio7 *Temperature Annual Range*

Description

TX of the warmest month minus TN of coldest month

Usage

```
bio7(data, tmin, tmax, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	medium temperature
tmin	min temperature
tmax	max temperature
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

BIO7

References

Hijmans RJ, Cameron SE, Parra JL, Jones PG, Jarvis A (2005) Very high resolution interpolated climate surfaces for global land areas. Int J Climatol 25:1965–1978. doi: 10.1002/joc.1276. http://www.worldclim.org/bioclim

Examples

```
data(data_all)
bio7(data = data_all$tg, tmin = data_all$tn, tmax = data_all$tx)
```

bio8 *TG of wettest quarter*

Description

TG of the wettest quarter of the year

Usage

```
bio8(pr, taverage, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

pr	precipitation
taverage	medium temperature
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

BIO8

References

Hijmans RJ, Cameron SE, Parra JL, Jones PG, Jarvis A (2005) Very high resolution interpolated climate surfaces for global land areas. Int J Climatol 25:1965–1978. doi: 10.1002/joc.1276. http://www.worldclim.org/bioclim

Examples

```
data(data_all)
bio8(pr = data_all$rr, taverage = data_all$tg)
```

bio9 *TG of driest quarter*

Description

TG of the driest quarter of the year

Usage

```
bio9(pr, taverage, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

pr	precipitation
taverage	medium temperature
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

BIO9

References

Hijmans RJ, Cameron SE, Parra JL, Jones PG, Jarvis A (2005) Very high resolution interpolated climate surfaces for global land areas. Int J Climatol 25:1965–1978. doi: 10.1002/joc.1276. http://www.worldclim.org/bioclim

Examples

```
data(data_all)
bio9(pr = data_all$rr, taverage =  data_all$tg)
```

---

calculate_all *Calculate all indexes*

Description

-

Usage

```
calculate_all(data, lat = NULL, time.scale = YEAR, data_names = NULL,
  index_result = c(1:138))
```

Arguments

data	data list
lat	latitude
time.scale	month, season or year
data_names	names of each period of time
index_result	index_result

Value

all indexes

calculate_all_scales *Calculate all indexes for all time scales*

Description

-

Usage

```
calculate_all_scales(data, lat = NULL)
```

Arguments

data	data list
lat	latitude

Value

all indexes

cc *Mean daily cloud cover*

Description

Mean daily cloud cover (

Usage

```
cc(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	cloud cover
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

mean CC

Examples

```
data(data_all)
cc(data = data_all$cloud)
```

cd *Percentage of cold days*

Description

Percentages of days with TX lower than the 10th percentile.

Usage

```
cd(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	maximum temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

percentage of cold days

Formula

$$cd = \frac{No.daysTX < 10p}{No.days} * 100$$

Examples

```
data(data_all)
cd(data=data_all$tx)
```

cdd *Cold spell duration*

Description

Count of days with at least 6 consecutive days when TN < 10th percentile

Usage

```
cdd(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	minimum temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Cold spell duration index

Examples

```
data(data_all)
cdd(data=data_all$tn)
```

---

cfd *Maximum consecutive frost days*

Description

Maximum number of consecutive days with TN < 0 Celsius

Usage

```
cfd(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	minimum temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

maximum consecutive frost

References

European Climate Assessment & Dataset. Indices dictionary. https://www.ecad.eu//indicesextremes/indicesdictionary.php

Examples

```
data(data_all)
cfd(data=data_all$tn)
```

ClimIndNews *ClimIndNews*

Description

Show the NEWS file of the **ClimInd** package.

Usage

```
ClimIndNews()
```

Details

(See description)

cmd *Climatic moisture deficit*

Description

ETo - Effective precipitation ETo - Effective Precipitation

Usage

```
cmd(eto, pr, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

eto	et0
pr	precipitation
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

CMD

References

Parks, S. A., Parisien, M. , Miller, C. , Holsinger, L. M. and Baggett, L. S. (2018), Fine-scale spatial climate variation and drought mediate the likelihood of reburning. Ecol Appl, 28: 573-586. doi:10.1002/eap.1671

Examples

```
data(data_all)
cmd(eto = data_all$evapotranspiration, pr = data_all$rr)
```

cn *Percentage of cold nights*

Description

Percentages of days with TN lower than the 10th percentile.

Usage

```
cn(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	minimum temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

percentage of cold nights

Formula

$$cn = \frac{No.daysTN < 10p}{No.days} * 100$$

Examples

```
data(data_all)
cn(data=data_all$tn)
```

csd *Maximum consecutive summer days*

Description

Maximum number of consecutive summer days (TX > 25 Celsius)

Usage

```
csd(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	maximum temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

consecutive summer days

Examples

```
data(data_all)
csd(data=data_all$tx)
```

---

d32 *Days TX32*

Description

Number of days whith TX >= 32 Celsius on the interval June-August.

Usage

```
d32(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	maximum temperature
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

temperature sums 1

Examples

```
data(data_all)
d32(data = data_all$tx)
```

d50mm *Heavy precipitation days*

Description

Number of days with precipitation above 50mm

Usage

```
d50mm(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	precipitation
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

heavy precipitation days

Examples

```
data(data_all)
d50mm(data = data_all$rr)
```

d95p *Very wet days*

Description

Days with precipitation > 95p

Usage

```
d95p(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	precipitation
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

R95p

References

Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

Examples

```
data(data_all)
d95p(data = data_all$rr)
```

Datasets *data_all*

Description

See wichita

Usage

```
data(data_all)
```

Format

An object of class `list` of length 22.

Details

See description.

---

dd *Dry days*

Description

Number of days with less than 1 mm

Usage

```
dd(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	precipitation
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

dry days

Examples

```
data(data_all)
dd(data = data_all$rr)
```

---

dd17 *Difference days above/below Tx17*

Description

(days tx > 17 Celsius)-(days TX < 17 Celsius)

Usage

```
dd17(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	maximum temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Temperature sums

Examples

```
data(data_all)
dd17(data=data_all$tx)
```

dfx21 *Days wind gusts above 21 m/s*

Description

Number of days with wind gusts above 21 m/s

Usage

```
dfx21(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	wind
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Gustmax

Examples

```
data(data_all)
dfx21(data = data_all$windGUST)
```

dr1mm *Wet days 1mm*

Description

Total number of wet days >= 1 mm

Usage

```
dr1mm(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	precipitation
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

RR1

References

European Climate Assessment & Dataset. Indices dictionary. https://www.ecad.eu//indicesextremes/indicesdictionary.php

Examples

```
data(data_all)
dr1mm(data = data_all$rr)
```

---

dr3mm *Wet days 3mm*

Description

Total number of Wet days >= 3mm

Usage

```
dr3mm(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	precipitation
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

RR3

References

European Climate Assessment & Dataset. Indices dictionary. https://www.ecad.eu//indicesextremes/indicesdictionary.php

Examples

```
data(data_all)
dr3mm(data = data_all$rr)
```

dtr *Diurnal temperature range*

Description

Mean difference between TX and TN.

Usage

```
dtr(tmax, tmin, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

tmax	maximum temperature
tmin	minimum temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Diurnal temperature range

Formula

$$DTR_j = \frac{\sum_{i=1}^{I}(TX_{ij} - TN_{ij})}{I}$$

References

Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5. https://www.ecad.eu/documents/WCDMP_72_TD_1500_en_1.pdf

Examples

```
data(data_all)
dtr(tmax=data_all$tx, tmin=data_all$tn)
```

`eai` *Emberger aridity index*

Description

Aridity index based on annual precipitation and temperature range

Usage

```
eai(pr, taverage, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

`pr`	precipitation
`taverage`	medium temperature
`data_names`	names of each period of time
`na.rm`	logical. Should missing values (including NaN) be removed?
`...`	...

Value

Emberger Aridity Index

Formula

$$EAI = \frac{100 * P}{Thm^2 - Tcm^2}$$

P = annual precipitation; Thm = Average temperature of the hottest month in Kelvin; Tcm= Average temperature of the coldest month in Kelvin

References

Emberger L. 1930. La végétation de la région méditerranéenne: essai d'une classification des groupements végétaux Revue Générale de Botanique, 42 (641–662), pp. 705-721

Examples

```
data(data_all)
eai(pr = data_all$rr, taverage = data_all$tg)
```

ep *Effective precipitation*

Description

Precipitation minus evapotranspiration

Usage

```
ep(eto, pr, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

eto	et0
pr	precipitation
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

effective precipitation

Examples

```
data(data_all)
ep(pr = data_all$rr, eto = data_all$evapotranspiration)
```

eto *Reference evapotranspiration*

Description

If data available using Fao-56 Penman-Monteith

Usage

```
eto(tmin, tmax, toa, w, lat, tdew, mde, radiation = NA,
  insolation = NA, rh = NA, data_names = NULL, time.scale = YEAR,
  na.rm = FALSE)
```

Arguments

tmin	tmin
tmax	tmax
toa	toa
w	w
lat	lat
tdew	tdew
mde	mde
radiation	radiation
insolation	insolation
rh	relative humidity
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Eto

References

Chiew, F.H.S., Kamaladasa, N.N., Malano, H.M., McMahon, T.A., 1995. Penman–Monteith FAO-24 reference crop evapotranspiration and class-A pan data in Australia. Agric. Water Manage. 28, 9–21

Examples

```
data(data_all)
eto(tmin = data_all$tn, tmax = data_all$tx,
     toa = data_all$radiationtoa, w = data_all$wind,
     lat=data_all$lat, tdew = data_all$dewpoint,
     mde=data_all$mde, radiation = data_all$radiation,
     insolation=data_all$insolation, rh = data_all$humidity)
```

---

etr *Extreme temperature range*

Description

Difference between the maximum TX and the minimum TN.

Usage

```
etr(tmax, tmin, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

tmax	maximum temperature
tmin	minimum temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

extreme temperature range

Examples

```
data(data_all)
etr(tmax=data_all$tx, tmin=data_all$tn)
```

---

fd *Frost days*

Description

Number of days with TN < 0 Celsius.

Usage

```
fd(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	minimum temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

frost days

References

Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

Examples

```
data(data_all)
fd(data=data_all$tn)
```

`ffdi` *McArthur Forest Fire Danger Index*

Description

The McArthur Forest Fire Danger Index (FFDI) is a good indication of the difficulty of fire suppression over a wide range of conditions. It estimates the amount of precipitation needed to bring the soil back to saturation and is computed from the Keetch-Byram Drought Index (KBDI) and Drought Factor (DF).

Usage

```
ffdi(taverage, pr, rh, w, data_names = NULL, time.scale = YEAR,
  na.rm = FALSE)
```

Arguments

`taverage`	medium temperature
`pr`	precipitation
`rh`	relative humidity
`w`	average wind
`data_names`	names of each period of time
`time.scale`	month, season or year
`na.rm`	logical. Should missing values (including NaN) be removed?

Value

FFDI

References

McArthur, A. G. (1967). Fire behaviour in eucalypt forests. Forestry and Timber Bureau Leaflet 107, 36 pp.

Examples

```
data(data_all)
ffdi(taverage = data_all$tg, pr=data_all$rr, rh=data_all$humidity, w=data_all$wind)
```

`fffi` *Finnish Forest Fire Index*

Description

Finnish forest fire index is determined from the surface moisture, by estimating the volumetric moisture of a 60 mm thick soil surface layer using potential evaporation and precipitation data.

Usage

```
fffi(data, evap, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

`data`	precipitation
`evap`	potential evapotranspiration
`data_names`	names of each period of time
`time.scale`	month, season or year
`na.rm`	logical. Should missing values (including NaN) be removed?

Value

FFFI

References

Venäläinen A, Heikinheimo M. 2003. The Finnish forest fire index calculation system. In Early Warning Systems for Natural Disaster Reduction, Zschau J, Kuppers A (eds). Springer: Berlin; 645–648.. Vajda, A., Venalainen, A., Suomi, I., Junila, P. and Makela, H., 2014. Assessment of forest fire danger in a boreal forest environment: description and evaluation of the operational system applied in Finland. Meteorol. Appl., 21: 879-887, DOI: 10.1002/met.1425

Examples

```
data(data_all)
fffi(data = data_all$rr, evap=data_all$evapotranspiration)
```

fg *Mean of daily mean wind strength*

Description

Mean of daily FG

Usage

```
fg(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	wind
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

FG

References

European Climate Assessment & Dataset. Indices dictionary. https://www.ecad.eu//indicesextremes/indicesdictionary.php

Examples

```
data(data_all)
fg(data = data_all$wind)
```

fg6bft *Number of days with averaged wind above 10.8m/s*

Description

Number of days with FG >=6 Bft (10.8 m/s)

Usage

```
fg6bft(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	wind
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

FG6Bft

References

ECA&D website: European Climate Assessment & Dataset. Indices dictionary. https://www.ecad.eu//indicesextremes/indicesdictionary.php

Examples

```
data(data_all)
fg6bft(data = data_all$wind)
```

---

fgcalm *Calm days*

Description

Number of calm days (FG <=2 m/s)

Usage

```
fgcalm(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	wind
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

FGcalm

References

ECA&D website: European Climate Assessment & Dataset. Indices dictionary. https://www.ecad.eu//indicesextremes/indicesdictionary.php

Examples

```
data(data_all)
fgcalm(data = data_all$wind)
```

`fod` *Foggy days*

Description

Number of days with fog.

Usage

```
fod(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

`data`	cloud base below 100 meter
`data_names`	names of each period of time
`time.scale`	month, season or year
`na.rm`	logical. Should missing values (including NaN) be removed?

Value

cloudy days

References

Rastogi, B., A.P. Williams, D.T. Fischer, S.F. Iacobellis, K. McEachern, L. Carvalho, C. Jones, S.A. Baguskas, and C.J. Still, 2016: Spatial and Temporal Patterns of Cloud Cover and Fog Inundation in Coastal California: Ecological Implications. Earth Interact., 20, 1–19, `https://doi.org/10.1175/EI-D-15-0033.1`

Examples

```
data(data_all)
fod(data = data_all$cloud100)
```

fpsc *Date of first permanent snow cover*

Description

First day of the longest period with consecutive snow cover day (day of the hydrological year). First day of the longest period with consecutive snow cover day

Usage

```
fpsc(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	snow depth
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

first permanent snowcover

Examples

```
data(data_all)
fpsc(data = data_all$snowdepth)
```

fsc *Date of first snow cover*

Description

First day when there is measurable snow cover (day of the hydrological year)

Usage

```
fsc(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	snow depth
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

first snowcover

Examples

```
data(data_all)
fsc(data = data_all$snowdepth)
```

`fsd` *Number of snow days*

Description

Number of snow days number of snow days No. snow days

Usage

```
fsd(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

`data`	snowfall
`data_names`	names of each period of time
`time.scale`	month, season or year
`na.rm`	logical. Should missing values (including NaN) be removed?

Value

freq. of snow days

References

European Climate Assessment & Dataset. Indices dictionary. `https://www.ecad.eu//indicesextremes/indicesdictionary.php`

Examples

```
data(data_all)
fsd(data = data_all$snowfall)
```

`fwi` *Canadian Fire Weather Index*

Description

The Canadian Forest Fire Weather Index is an indicator of fire weather intensity and is used to represent potential fire danger. It is computed from daily values of precipitation, temperature, near-surface wind and relative humidity dimensionless, see Van Wagner (1987).

Usage

```
fwi(taverage, rh, w, pr, dew_point, lat, data_names = NULL,
  time.scale = YEAR, na.rm = FALSE)
```

Arguments

`taverage`	medium temperature
`rh`	relative humidity
`w`	average wind
`pr`	precipitation
`dew_point`	dew_point
`lat`	latitude
`data_names`	names of each period of time
`time.scale`	month, season or year
`na.rm`	logical. Should missing values (including NaN) be removed?

Value

FWI

References

Van Wagner CE. 1987. Development and structure of the Canadian forest fire weather index system. Technical Report 35, Canadian Forestry Service: Ottawa, Ontario. Bedia, J., Herrera, S., Gutiérrez, J. M., Zavala, G., Urbieta, I. R., & Moreno, J. M. (2012). Sensitivity of fire weather index to different reanalysis products in the iberian peninsula. Natural Hazards and Earth System Science, 12(3), 699-708. doi:10.5194/nhess-12-699-2012 ## @importance Important application for fire prevention

Examples

```
data(data_all)
fwi(taverage = data_all$tg, rh = data_all$humidity, w = data_all$wind,
     pr = data_all$rr, dew_point=data_all$dewpoint, lat = data_all$lat)
```

fxx *Daily maximum wind gust*

Description

Maximum value of daily maximum wind gust (m/s)

Usage

```
fxx(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	maximum wind gust
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

FXx

References

European Climate Assessment & Dataset. Indices dictionary. https://www.ecad.eu//indicesextremes/indicesdictionary.php

Examples

```
data(data_all)
fxx(data = data_all$windGUST)
```

gd4 *Growing degree days*

Description

Sum of degree days of TG over 4 Celsius (the daily mean temperature is less than 4 celsius, it is set equal to 4 celsius)

Usage

```
gd4(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	medium temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

GD4

References

McMaster, G. S., & Wilhelm, W. W. (1997). Growing degree-days: One equation, two interpretations. Agricultural and Forest Meteorology, 87(4), 291-300

Examples

```
data(data_all)
gd4(data=data_all$tg)
```

---

gsl *Growing season length*

Description

Annual count of days between the first span of at least 6 days with TG > 5 Celsius and first span after 1 July of 6 days with TG < 5 Celsius.

Usage

```
gsl(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	mean temperature
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

growing season length

References

Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

Examples

```
data(data_all)
gsl(data=data_all$tg)
```

`gsr` *Growing season precipitation*

Description

Growing season (april to october) total precipitation

Usage

```
gsr(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

`data`	precipitation
`data_names`	names of each period of time
`na.rm`	logical. Should missing values (including NaN) be removed?
`...`	...

Value

GSP

Examples

```
data(data_all)
gsr(data = data_all$rr)
```

gtg *Mean TG*

Description

Mean of daily mean air temperature

Usage

```
gtg(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	medium temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Average temperature

References

European Climate Assessment & Dataset. Indices dictionary. https://www.ecad.eu//indicesextremes/indicesdictionary.php

Examples

```
data(data_all)
gtg(data=data_all$tg)
```

gtn *Mean TN*

Description

Mean of daily minimum air temperature

Usage

```
gtn(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	minimum temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Average temperature

References

European Climate Assessment & Dataset. Indices dictionary. https://www.ecad.eu//indicesextremes/indicesdictionary.php

Examples

```
data(data_all)
gtn(data=data_all$tn)
```

---

gtx *Mean TX*

Description

Mean of daily maximum air temperature

Usage

```
gtx(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	maximum temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Average temperature

References

European Climate Assessment & Dataset. Indices dictionary. https://www.ecad.eu//indicesextremes/indicesdictionary.php

Examples

```
data(data_all)
gtx(data=data_all$tg)
```

`hciu` *Holliday Climate Index Urban*

Description

Holliday Climate Index for Urban destinations (Scott et all, 2016) (Tmax,wind,cloudiness,RH, precipitation) Scott, D., Rutty, M., Amelung, B. and Tang, M. (2016): An inter-comparison of the Holiday Climate Index (HCI) and the Tourism Climate Index (TCI), Atmosphere, 7, 80, doi:10.3390/atmos7060080 Holliday Climate Index for Urban destinations (Scott et all, 2016) (TX, wind, cloudiness, RH, precipitation) Scott, D., Rutty, M., Amelung, B. and Tang, M. (2016): An inter-comparison of the Holiday Climate Index (HCI) and the Tourism Climate Index (TCI), Atmosphere, 7, 80, doi:10.3390/atmos7060080 HCI : Urban= 4*TC +2*A+(3*precipitation+wind) where TC=thermal comfort (as a function of Tmax [C] and RH [

Usage

```
hciu(pr, w, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

`pr`	precipitation
`w`	average wind
`data_names`	names of each period of time
`time.scale`	month, season or year
`na.rm`	logical. Should missing values (including NaN) be removed?

Value

HCIU

References

Scott, D., Rutty, M., Amelung, B. and Tang, M. (2016): An inter-comparison of the Holiday Climate Index (HCI) and the Tourism Climate Index (TCI), Atmosphere, 7, 80, doi:10.3390/atmos7060080

Examples

```
data(data_all)
hciu(pr = data_all$rr, w=data_all$wind)
```

`hd17` *Heating degree days*

Description

accumulated degree when TG is below 17 Celsius

Usage

```
hd17(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

`data`	mean temperature
`data_names`	names of each period of time
`time.scale`	month, season or year
`na.rm`	logical. Should missing values (including NaN) be removed?

Value

HD17

Formula

$$HD17_j = \sum_{j-1}^{I} (17^oC - TG_i j)$$

References

Quayle, R. G., & Diaz, H. F. (1980). Heating degree day data applied to residential heating energy consumption. Journal of Applied Meteorology, 19(3), 241-246. https://doi.org/10.1175/1520-0450(1980)019<0241:HDDDAT>2.0.CO;2

Examples

```
data(data_all)
hd17(data=data_all$tg)
```

hi *Heat Index*

Description

Combines air temperature and relative humidity to determine the human-perceived equivalent temperature

Usage

```
hi(taverage, rh, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

taverage	medium temperature
rh	relative humidity
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Heat Index

Formula

$HI = -42,379+2,04901523*TG+10,14333127*rh-0,22475541*TG*rh-0.00683783*TG^2-0.05481717*rh^2+0.01$

. Where TG is air temperature in ºF and rh is relative humidity in

References

http://www.wpc.ncep.noaa.gov/html/heatindex_equation.shtml

Examples

```
data(data_all)
hi(taverage = data_all$tg, rh = data_all$humidity)
```

hsd *Heavy snowy days*

Description

Number of days with snow depth more than 50 cm.

Usage

```
hsd(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	snow depth
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

heavy snowy days

References

European Climate Assessment & Dataset. Indices dictionary. https://www.ecad.eu//indicesextremes/indicesdictionary.php

Examples

```
data(data_all)
hsd(data = data_all$snowdepththickness)
```

id *Ice days*

Description

Number of days with TX < 0 Celsius.

Usage

```
id(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	maximum temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

ice days

References

Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

Examples

```
data(data_all)
id(data=data_all$tx)
```

---

jci *Johansson Continentality Index*

Description

The Johansson Continentality Index is usually used for the climatic differentiation between continental and oceanic climates.

Usage

```
jci(data, data_names = NULL, value, na.rm = FALSE, ...)
```

Arguments

data	medium temperature
data_names	names of each period of time
value	lat
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

JCI

Formula

$$JCI = \frac{1.7(Thm - Tcm)}{sinf} - 20.4$$

Thm = Average temperature of the hottest month (Celsius); Tcm = Average temperature of the coldest month (Celsius); f = geographical latitude

References

Chronopoulou-Sereli A. 1996. Courses of Agricultural Meteorology.Publications Agricultural University of Athens: Athens, OH

Examples

```
data(data_all)
jci(data = data_all$tg, value = data_all$lat)
```

---

kbdi *Keetch-Byran Drought Index*

Description

The Keetch-Byram Drought Index (KBDI) is an indicator of drought conditions and is used to predict wildfire severity.

Usage

```
kbdi(taverage, pr, data_names = NULL, time.scale = YEAR,
  na.rm = FALSE)
```

Arguments

taverage	medium temperature
pr	precipitation
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

KBDI

References

Keetch, J.J. and Byram, G.M. (1968). A drought index for forest fire control. Tech. Rep., USDA Forest Service Research Paper SE-38, North Carolina, USA. Alexander, M.E., 1990. Computer calculation of the Keetch-Byram Drought Index - programmers beware. Fire Management Notes 51, 23–25.

Examples

```
data(data_all)
kbdi(taverage = data_all$tg, pr=data_all$rr)
```

`koi` *Kerner Oceanity Index*

Description

KOI analysed the oceanity assuming that marine climates have colder spring months in comparison with the autum nmonth.

Usage

```
koi(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

`data`	medium temperature
`data_names`	names of each period of time
`na.rm`	logical. Should missing values (including NaN) be removed?
`...`	...

Value

Kerner Oceanity Index

Formula

$$KOI = \frac{100(TGo - TGa)}{Thm - Tcm}$$

TGo = Average temperature of October TGa = Average temperature of April Thm = Average temperature of the hottest month (Celsius); Tcm = Average temperature of the coldest month (Celsius)

References

Zambakas J. 1992.General Climatology. Department of Geology,National & Kapodistrian University of Athens, Athens. Gavilan RG. 2005. The use of climatic parameters and indices in vege-tation distribution. A case study in the Spanish System Central.Int. J.Biometeorol.50: 111–120.

Examples

```
data(data_all)
koi(data = data_all$tg)
```

ldp *Longest dry period*

Description

Maximum length of consecutive dry days (RR<1)

Usage

```
ldp(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	precipitation
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

longest dry period

References

Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

Examples

```
data(data_all)
ldp(data = data_all$rr)
```

lpsc *Date of last permanent snow cover*

Description

Last day of the longest period with consecutive snow cover day (day of the hydrological year).

Usage

```
lpsc(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	snow depth
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

last permanent snowcover

Examples

```
data(data_all)
lpsc(data = data_all$snowdepth)
```

---

lwp *Longest wet period*

Description

Maximum length of consecutive wet days (RR>=1)

Usage

```
lwp(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	precipitation
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

longest wet period

References

Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

Examples

```
data(data_all)
lwp(data = data_all$rr)
```

`mai` *De Martonne aridity index*

Description

De Martonne aridity index is the ratio between the annual amount of precipitation and anual mean of temperature plus 10 Celsius.

Usage

```
mai(pr, taverage, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

`pr`	precipitation
`taverage`	medium temperature
`data_names`	names of each period of time
`na.rm`	logical. Should missing values (including NaN) be removed?
`...`	...

Value

Martonne Aridity Index

Formula

$$MAI = \frac{P}{TG + 10}$$

P = annual precipitation (mm); TG = mean annual air temperature (Celsius)

References

De Martonne E., 1926. Une nouvelle fonction climatologique: L'indice d'aridité. La Meteorologie, 449-458.

Examples

```
data(data_all)
mai(pr = data_all$rr, taverage = data_all$tg)
```

`mfi` *Modified Fournier Index*

Description

The precipitation concentration index is frequently associated to erosion risk. Values: 0-60 very low; 60-90 Low; 90-120 moderate; 120-160 high; > 160 very high.

Usage

```
mfi(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

`data`	precipitation
`data_names`	names of each period of time
`na.rm`	logical. Should missing values (including NaN) be removed?
`...`	...

Value

MFI

Formula

$$MFI = \sum_{i=1}^{12} \frac{P_i^2}{P_t}$$

References

Fournier F. 1960. Climat et Erosion. PUF: Paris. Arnoldus HM. 1980. An approximation of the rainfall factor in the Uni-versal Soil Loss Equation. In Assessments of Erosion, de Boodts M,Gabriels D (eds). John Wiley and Sons Ltd, Chichester 127–132. De Luis M., González-Hidalgo J.C., Longares L.A. Is rainfal erosivity increasing in the Mediterranean Iberian Peninsula?. Land Degradation & Development, 21: 139-144.

Examples

```
data(data_all)
mfi(data = data_all$rr)
```

mi *Mould index*

Description

Number of days with a relative humidity over 90

Usage

```
mi(taverage, rh, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

taverage	medium temperature
rh	relative humidity
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Mould index

Examples

```
data(data_all)
mi(taverage = data_all$tg, rh = data_all$humidity)
```

mni *Modified Nesterov Index*

Description

The Modified Nesterov Index (MNI) reflects the relationship between observed weather conditions and fire occurrence. It is a cumulative index computed from daily temperature and dewpoint temperature, which is reset when a certain precipitation value is reached.

Usage

```
mni(dew_point, taverage, rh, pr, data_names = NULL, time.scale = YEAR,
  na.rm = FALSE)
```

Arguments

dew_point	dew point
taverage	medium temperature
rh	relative humidity
pr	precipitation
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

MNI

References

Groisman, P.Y., et al., 2007. Global and Planetary Change 56, 371–386.

Examples

```
data(data_all)
mni(dew_point=data_all$dewpoint, taverage=data_all$tg, rh=data_all$humidity, pr=data_all$rr)
```

---

moi *Marsz Oceanity Index*

Description

MOI = (0.731 * geographic latitude grados + 1.767) / the annual range of monthly mean air temperatures grados

Usage

```
moi(data, value, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	medium temperature
value	lat
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

n0to10

Formula

$$MOI = \frac{0.731\phi + 1.767}{Thm - Tcm}$$

$$\phi$$

= geographical latitude; Thm = Average temperature of the hottest month (Celsius); Tcm = Average temperature of the coldest month (Celsius)

References

Marsz A, Rakusa-Suszczewskis S. 1987. Charakterystyka ekologiczna rejonu Zatoki Admiralicji (King George Island, SouthShetland Islands). 1. Klimat i obszary wolne od lodu.Kosmos36:103–127.

Examples

```
data(data_all)
moi(data = data_all$tg, value = data_all$lat)
```

`ms` *Maximum snow depth*

Description

Maximum snow depth (m)

Usage

```
ms(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

`data`	snow depth
`data_names`	names of each period of time
`time.scale`	month, season or year
`na.rm`	logical. Should missing values (including NaN) be removed?

Value

maximum snow depth

Examples

```
data(data_all)
ms(data = data_all$snowdepththickness)
```

msd *Mild snowy days*

Description

number of days with snow depth > 5 cm.

Usage

```
msd(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	snow depth
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

mild snowy days

References

European Climate Assessment & Dataset. Indices dictionary. https://www.ecad.eu//indicesextremes/indicesdictionary.php

Examples

```
data(data_all)
msd(data = data_all$snowdepththickness)
```

ngsr *Non-growing season precipitation*

Description

Total precipitation from October to April

Usage

```
ngsr(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	precipitation
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

non growing precipitation

Examples

```
data(data_all)
ngsr(data = data_all$rr)
```

---

ntg *Minimum TG*

Description

Minimum value of daily mean air temperature

Usage

```
ntg(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	medium temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Average temperature

Examples

```
data(data_all)
ntg(data=data_all$tg)
```

ntn *Minimum TN*

Description

Minimum of daily minimum air temperature

Usage

```
ntn(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	minimum temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Average temperature

References

Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5. https://www.ecad.eu/documents/WCDMP_72_TD_1500_en_1.pdf

Examples

```
data(data_all)
ntn(data=data_all$tn)
```

ntx *Minimum TX*

Description

Minimum of daily maximum air temperature

Usage

```
ntx(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	maximum temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Average temperature

References

Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5. https://www.ecad.eu/documents/WCDMP_72_TD_1500_en_1.pdf

Examples

```
data(data_all)
ntx(data=data_all$tx)
```

---

ogs10 *Onset of growing season 10 days*

Description

Date of the start of the first span with at least 10 days with TG > 5 Celsius

Usage

```
ogs10(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	medium temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Onset of growing season 2

Examples

```
data(data_all)
ogs10(data=data_all$tg)
```

ogs6 *Onset of growing season 6 days*

Description

Date of the start of the first span with at least 6 days with TG >5 Celsius

Usage

```
ogs6(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	medium temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Onset of growing season 1

Examples

```
data(data_all)
ogs6(data=data_all$tg)
```

pci *Precipitation Concentration Index*

Description

Index to evaluate precipitation heterogeneity at a monthly scale. Values <10 (uniform monthly rainfall distribution); values 11-15 (moderate concentration of precipitation); values 16-20 (irregular distribution); and >20 ((high precipitation concentration)

Usage

```
pci(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	precipitation
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

PCI

Formula

$$PCI = \frac{\sum_{i=1}^{12} P_i^2}{(P_t)^2} * 100$$

References

Oliver, J.E. (1980) Monthly precipitation distribution: a comparative index. Professional Geographer, 32, 300–309

Examples

```
data(data_all)
pci(data = data_all$rr)
```

`pici` *Pinna Combinative Index*

Description

Pinna combinative index is an aridity–humidity index

Usage

```
pici(pr, taverage, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

`pr`	precipitation
`taverage`	medium temperature
`data_names`	names of each period of time
`na.rm`	logical. Should missing values (including NaN) be removed?
`...`	...

Value

Pinna Combinative index

Formula

$$PICI = \frac{1}{2}\left(\frac{P}{TG+10} + \frac{12Pdm}{TGdm+10}\right)$$

P = annual precipitation (mm); TG = annual mean temperature (Celsius); Pdm= precipitation of the driest month; TGdm= temperature of the driest month

References

Zambakas J. 1992. General Climatology. Department of Geology, National & Kapodistrian University of Athens: Athens, Greece.

Examples

```
data(data_all)
pici(pr = data_all$rr, taverage = data_all$tg)
```

---

ptg *Sums positive*

Description

Sums of positive TG calculated for the 1st of February to the 10th April interval

Usage

```
ptg(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

`data`	medium temperature
`data_names`	names of each period of time
`na.rm`	logical. Should missing values (including NaN) be removed?
`...`	...

Value

temperature sums 5

Examples

```
data(data_all)
ptg(data = data_all$tg)
```

r10mm *Days precipitation >= R10mm*

Description

Days with daily precipitation amount >= 10mm

Usage

```
r10mm(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	precipitation
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

R10mm

References

Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

Examples

```
data(data_all)
r10mm(data = data_all$rr)
```

r20mm *Days precipitation >= R20mm*

Description

Days with daily precipitation amount >= 20mm

Usage

```
r20mm(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	precipitation
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

R20mm

References

Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

Examples

```
data(data_all)
r20mm(data = data_all$rr)
```

---

r95tot *Percentage precipitation of very wet days*

Description

Precipitation at days exceeding the 95percentile divided by total precipitation expressed in percentage

Usage

```
r95tot(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	precipitation
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

PVWD

Examples

```
data(data_all)
r95tot(data = data_all$rr)
```

r99tot *Precipitation fraction extremely wet days*

Description

Precipitation at days exceeding the 99percentile divided by total precipitation expressed in percentage

Usage

```
r99tot(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	precipitation
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

PEWD

Examples

```
data(data_all)
r99tot(data = data_all$rr)
```

rti *Total precipitation*

Description

Total amounts of precipitation

Usage

```
rti(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	precipitation
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

total precipitation

Examples

```
data(data_all)
rti(data = data_all$rr)
```

---

rtwd *Total precipitation wet days*

Description

Precipitation amount on days with RR >= 1 mm

Usage

```
rtwd(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	precipitation
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

precipitation in wet days

References

European Climate Assessment & Dataset. Indices dictionary. https://www.ecad.eu//indicesextremes/indicesdictionary.php

Examples

```
data(data_all)
rtwd(data = data_all$rr)
```

rx *Maximum precipitation*

Description

The highest amount of daily precipitation

Usage

```
rx(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	precipitation
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

maximum precipitation

References

Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

Examples

```
data(data_all)
rx(data = data_all$rr)
```

rx5d *Maximum 5 days R*

Description

Maximum consecutive 5-day precipitation

Usage

```
rx5d(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	precipitation
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Rx5day

References

Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

Examples

```
data(data_all)
rx5d(data = data_all$rr)
```

---

scd *Number of snow covered days*

Description

Number of snow covered days (snow depth > 0)

Usage

```
scd(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	snow depth
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

snow covered days

Examples

```
data(data_all)
scd(data = data_all$snowdepth)
```

sd0_10 *Snow depth 1-10*

Description

Number of days with snow depth in the range 1-10 cm

Usage

```
sd0_10(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	snow depth
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

SD0_10

References

European Climate Assessment & Dataset. Indices dictionary. https://www.ecad.eu//indicesextremes/indicesdictionary.php

Examples

```
data(data_all)
sd0_10(data = data_all$snowdepthhthickness)
```

sd10_20 *Snow depth 10-20*

Description

The number of days with snow depth of 10-20 cm

Usage

```
sd10_20(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	snow depth
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

SD10_20

References

European Climate Assessment & Dataset. Indices dictionary. https://www.ecad.eu//indicesextremes/indicesdictionary.php

Examples

```
data(data_all)
sd10_20(data = data_all$snowdepththickness)
```

---

sdd *Snow depth*

Description

Mean of daily snow depth mean of daily snow depth

Usage

```
sdd(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	snow depth
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

snow depth

References

European Climate Assessment & Dataset. Indices dictionary. https://www.ecad.eu//indicesextremes/indicesdictionary.php

Examples

```
data(data_all)
sdd(data = data_all$snowdepththickness)
```

`sdii` *Simple precipitation intensity index*

Description

Sum of precipitation in wet days (days with >1mm of precipitation), and dividing that by the number of wet days in the period.

Usage

```
sdii(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

`data`	precipitation
`data_names`	names of each period of time
`time.scale`	month, season or year
`na.rm`	logical. Should missing values (including NaN) be removed?

Value

SDII

References

Michele Brunetti, Maurizio Maugerib, Teresa Nanni, (2001) Changes in total precipitation, rainy days and extreme events in northeastern Italy, International Journal of Climatology

Examples

```
data(data_all)
sdii(data = data_all$rr)
```

snd *Sunny days*

Description

Days with mean cloud cover less than 10

Usage

```
snd(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	cloud cover
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

SND

Examples

```
data(data_all)
snd(data = data_all$cloud)
```

spei1 *Standardised Precipitation-Evapotranspiration Index 1*

Description

Standardized precipitation-evapotranspiration index calculated at 1-month time scale

Usage

```
spei1(eto, pr, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

eto	et0
pr	precipitation
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

SPEI

References

Vicente-Serrano, S. M., Beguería, S. and López-Moreno, J. I.: A multiscalar drought index sensitive to global warming: The standardized precipitation evapotranspiration index, J. Clim., 23(7), doi:10.1175/2009JCLI2909.1, 2010.

Examples

```
data(data_all)
spei1(eto = data_all$evapotranspiration, pr = data_all$rr)
```

---

spei12 *Standardised Precipitation-Evapotranspiration Index 12*

Description

Standardized precipitation-evapotranspiration index calculated at 12-month time scale

Usage

```
spei12(eto, pr, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

eto	et0
pr	precipitation
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

SPEI

References

Vicente-Serrano, S. M., Beguería, S. and López-Moreno, J. I.: A multiscalar drought index sensitive to global warming: The standardized precipitation evapotranspiration index, J. Clim., 23(7), doi:10.1175/2009JCLI2909.1, 2010.

Examples

```
data(data_all)
spei12(eto = data_all$evapotranspiration, pr = data_all$rr)
```

spei3 *Standardised Precipitation-Evapotranspiration Index 3*

Description

Standardized precipitation-evapotranspiration index calculated at 3-month time scale

Usage

```
spei3(eto, pr, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

eto	et0
pr	precipitation
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

SPEI

References

Vicente-Serrano, S. M., Beguería, S. and López-Moreno, J. I.: A multiscalar drought index sensitive to global warming: The standardized precipitation evapotranspiration index, J. Clim., 23(7), doi:10.1175/2009JCLI2909.1, 2010.

Examples

```
data(data_all)
spei3(eto = data_all$evapotranspiration, pr = data_all$rr)
```

spei6 *Standardised Precipitation-Evapotranspiration Index 6*

Description

Standardized precipitation-evapotranspiration index calculated at 6-month time scale

Usage

```
spei6(eto, pr, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

eto	et0
pr	precipitation
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

SPEI

References

Vicente-Serrano, S. M., Beguería, S. and López-Moreno, J. I.: A multiscalar drought index sensitive to global warming: The standardized precipitation evapotranspiration index, J. Clim., 23(7), doi:10.1175/2009JCLI2909.1, 2010.

Examples

```
data(data_all)
spei6(eto = data_all$evapotranspiration, pr = data_all$rr)
```

---

spi1 *Standardized precipitation index 1*

Description

Standardized precipitation index calculated at 1-month time scale

Usage

```
spi1(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	precipitation
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

SPI

References

McKee, T. B., Doesken, N. J. and Kleist, J.: The relationship of drought frequency and duration to time scales, Eighth Conf. Appl. Climatol., 179–184, 1993.

Examples

```
data(data_all)
spi1(data = data_all$rr)
```

`spi12` *Standardized precipitation index 12*

Description

Standardized precipitation index calculated at 12-month time scale

Usage

```
spi12(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

`data`	precipitation
`data_names`	names of each period of time
`na.rm`	logical. Should missing values (including NaN) be removed?
`...`	...

Value

SPI

References

McKee, T. B., Doesken, N. J. and Kleist, J.: The relationship of drought frequency and duration to time scales, Eighth Conf. Appl. Climatol., 179–184, 1993.

Examples

```
data(data_all)
spi12(data = data_all$rr)
```

spi3 *Standardized precipitation index 3*

Description

Standardized precipitation index calculated at 3-month time scale

Usage

```
spi3(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	precipitation
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

SPI

References

McKee, T. B., Doesken, N. J. and Kleist, J.: The relationship of drought frequency and duration to time scales, Eighth Conf. Appl. Climatol., 179–184, 1993.

Examples

```
data(data_all)
spi3(data = data_all$rr)
```

spi6 *Standardized precipitation index 6*

Description

Standardized precipitation index calculated at 6-month time scale

Usage

```
spi6(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	precipitation
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

SPI

References

McKee, T. B., Doesken, N. J. and Kleist, J.: The relationship of drought frequency and duration to time scales, Eighth Conf. Appl. Climatol., 179–184, 1993.

Examples

```
data(data_all)
spi6(data = data_all$rr)
```

---

ss *Snowfall sum*

Description

Sum of snowfall

Usage

```
ss(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	snowfall
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

n0to10

Examples

```
data(data_all)
ss(data = data_all$snowfallmm)
```

ssd *Sum of sunshine duration*

Description

Sum of sunshine duration (hours)

Usage

```
ssd(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	sunshine duration
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

SSD, h

References

European Climate Assessment & Dataset. Indices dictionary. https://www.ecad.eu//indicesextremes/indicesdictionary.php

Examples

```
data(data_all)
ssd(data = data_all$insolation)
```

ssp *Sunshine duration percentage*

Description

Sunshine duration fraction with respect to day length (

Usage

```
ssp(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	sunshine duration
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

ssp

Formula

$$SSP = \frac{SS}{SSmax} * 100$$

SS: sum of sunshine duration (h); SSmax: maximun daylight (h)

References

European Climate Assessment & Dataset. Indices dictionary. https://www.ecad.eu//indicesextremes/indicesdictionary.php

Examples

```
data(data_all)
ssp(data = data_all$insolation)
```

---

stn10 *Sums TN-10*

Description

Sum of degree days when TN <=-10 Celsius recorded in December-February interval

Usage

```
stn10(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	minimum temperature
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

temperature sums 3

Examples

```
data(data_all)
stn10(data = data_all$tn)
```

`stn15` *Sums TN-15*

Description

Sum of degree days when TN <= -15 Celsius recorded in December-February interval

Usage

```
stn15(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

`data`	minimum temperature
`data_names`	names of each period of time
`na.rm`	logical. Should missing values (including NaN) be removed?
`...`	...

Value

temperature sums 2

Examples

```
data(data_all)
stn15(data = data_all$tn)
```

stx32 *Sums TX32*

Description

Sum of degree days when TX >= 32 Celsius on the interval June-August. The 32 celsius limit is the critical biological threshold for the maximum air temperature from which the physiological optimal growth and development of wheat and maize plants.

Usage

```
stx32(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	maximum temperature
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

temperature sums 1

Examples

```
data(data_all)
stx32(data = data_all$tx)
```

sud *Summer days*

Description

Number of days with maximum temperature > 25 Celsius. Number of days with TX >25 Celsius.

Usage

```
sud(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	maximum temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Summer days

References

Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

Examples

```
data(data_all)
sud(data=data_all$tx)
```

---

ta_o *Growing season (Apr-Oct)*

Description

Growing season (april to october) mean TG

Usage

```
ta_o(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	medium temperature
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

Growing season temperature 1

Examples

```
data(data_all)
ta_o(data=data_all$tg)
```

`tci` *Tourism Climatic Index*

Description

Standard index computed by ECA&D; Described at Miezkowski (1985), conceptual formula: TCI = 4cid + cia + 2R + 2S + W, where CId is a daytime comfort index, CIa a daily comfort index, R is cumulated rainfall, S the daily sunshine hours and W wind speed Represents a quantitative evaluation of world climate for the purposes of tourism and is a composite measure of the climatic well-being of tourists. TCI = 4cid + cia + 2R + 2S + W, where CId is a daytime comfort index, CIa a daily comfort index, R is cumulated rainfall, S the daily sunshine hours and W wind speed

Usage

```
tci(data, sunshine, w, data_names = NULL, time.scale = YEAR,
  na.rm = FALSE)
```

Arguments

`data`	precipitation
`sunshine`	net radiation
`w`	average wind
`data_names`	names of each period of time
`time.scale`	month, season or year
`na.rm`	logical. Should missing values (including NaN) be removed?

Value

TCI

References

Mieczkowski, Z. (1985). The tourism climatic index: a method of evaluating world climates for tourism. The Canadian Geographer/Le Géographe canadien, 29(3), 220-233.

Examples

```
data(data_all)
tci(data=data_all$rr, sunshine=radiation.value, w=w.value)
```

`tci60` *Good tourism days TCI>60*

Description

Number of days TCI>60, standard ECA&D Number of days TCI>60 (see TCI) TCI = 8 Cld + 2 Cla + 4 R + 4 S + 2 W. Let TCIij be the daily value of the Tourism Climatic Index at day i of period j. Then counted is the number of days where: TCIij>=60. Where C ld is a daytime comfort index, consisting of the mean maximum air temperature Ta, max (°C) and the mean minimum relative humidity RH (

Usage

```
tci60(data, sunshine, w, data_names = NULL, time.scale = YEAR,
  na.rm = FALSE)
```

Arguments

`data`	precipitation
`sunshine`	net radiation
`w`	average wind
`data_names`	names of each period of time
`time.scale`	month, season or year
`na.rm`	logical. Should missing values (including NaN) be removed?

Value

TCI60

References

Mieczkowski, Z. (1985). The tourism climatic index: a method of evaluating world climates for tourism. The Canadian Geographer/Le Géographe canadien, 29(3), 220-233.

Examples

```
data(data_all)
tci60(data=data_all$rr, sunshine=data_all$radiation, w=data_all$wind)
```

`tci80` *Excellent tourism days TCI>80*

Description

Number of days TCI>80, standard ECA&D Number of days TCI>80 (see TCI) TCI = 8 Cld + 2 Cla + 4 R + 4 S + 2 W. Let TCIij be the daily value of the Tourism Climatic Index at day i of period j. Then counted is the number of days where: TCIij>=80. Where C ld is a daytime comfort index, consisting of the mean maximum air temperature Ta, max (°C) and the mean minimum relative humidity RH (

Usage

```
tci80(data, sunshine, w, data_names = NULL, time.scale = YEAR,
  na.rm = FALSE)
```

Arguments

`data`	precipitation
`sunshine`	net radiation
`w`	average wind
`data_names`	names of each period of time
`time.scale`	month, season or year
`na.rm`	logical. Should missing values (including NaN) be removed?

Value

TCI80

References

Mieczkowski, Z. (1985). The tourism climatic index: a method of evaluating world climates for tourism. The Canadian Geographer/Le Géographe canadien, 29(3), 220-233.

Examples

```
data(data_all)
tci80(data=data_all$rr, sunshine=data_all$radiation, w=data_all$wind)
```

tm_s *Growing season(May-Sep)*

Description

Growing season (may to september) mean TG

Usage

```
tm_s(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	medium temperature
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

Growing season temperature 2

Examples

```
data(data_all)
tm_s(data=data_all$tg)
```

tn *Tropical nights*

Description

Number of days with TN > 20 Celsius.

Usage

```
tn(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	minimum temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Tropical nights

References

Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

Examples

```
data(data_all)
tn(data=data_all$tn)
```

`uai` *UNEP Aridity Index*

Description

P/Eto

Usage

```
uai(eto, pr, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

`eto`	et0
`pr`	precipitation
`data_names`	names of each period of time
`time.scale`	month, season or year
`na.rm`	logical. Should missing values (including NaN) be removed?

Value

iUNEP

References

Huiping Huang, Yuping Han, Mingming Cao, Jinxi Song, and Heng Xiao Spatial-Temporal Variation of Aridity Index of China during 1960–2013. Advances in Meteorology, vol. 2016, Article ID 1536135, 10 pages, 2016. https://doi.org/10.1155/2016/1536135

Examples

```
data(data_all)
uai(eto = data_all$evapotranspiration, pr = data_all$rr)
```

utci *Universal Thermal Climate Index*

Description

The Universal Thermal Climate Index is expressed as an equivalent ambient temperature (Celsius) of a reference environment providing the same physiological response of a reference person as the actual environment http://www.utci.org/ http://www.utci.org/utci_doku.php Copy https://github.com/alfcrisci/rBiometeo Given air temperature (Celsius), relative humidity (%), wind velocity (m/sec) and mean radiant temperature (tmrt in Celsius degree) gives the Universal Thermal Climate Index in Celsius.

Usage

```
utci(ta, rh, wind, tmrt, data_names = NULL, time.scale = YEAR,
  na.rm = FALSE)
```

Arguments

ta	medium temperature
rh	humidity
wind	average wind
tmrt	radiation temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

UTCI

References

Blazejczyk, K., Epstein, Y., Jendritzky, G., Staiger, H., & Tinz, B. (2012). Comparison of UTCI to selected thermal indices. International Journal of Biometeorology, 56(3), 515-535. doi:10.1007/s00484-011-0453-2

Examples

```
data(data_all)
utci(ta = data_all$tg, rh = data_all$dewpoint, wind = data_all$wind,
     tmrt = data_all$"RADIATIONTEMPERATURE")
```

vcd *Very cold days*

Description

Days with TN <1st percentile.

Usage

```
vcd(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	minimum temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Very cold days

Examples

```
data(data_all)
vcd(data=data_all$tn)
```

vdtr *Mean daily difference DTR*

Description

Mean absolute day-to-day difference in DTR

Usage

```
vdtr(tmax, tmin, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

tmax	maximum temperature
tmin	minimum temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

vDTR

Formula

$$vDTR_j = \frac{\sum_{i=1}^{I} \mid (TX_{ij} - TN_{ij}) - (TX_{i-1,j} - TN_{i-1,j}) \mid}{I}$$

References

European Climate Assessment & Dataset. Indices dictionary. https://www.ecad.eu//indicesextremes/indicesdictionary.php

Examples

```
data(data_all)
vdtr(tmax=data_all$tx, tmin=data_all$tn)
```

---

vwd *Very warm days*

Description

Days with TX >99th percentile per year.

Usage

```
vwd(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	maximum temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Very warm days

Examples

```
data(data_all)
vwd(data=data_all$tx)
```

wci *Wind chill index*

Description

Wind chill index is the lowering of body temperature due to the passing-flow of lower-temperature air. It combines air temperature and wind speed.

Usage

```
wci(taverage, w, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

taverage	medium temperature
w	average wind
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

WCI

Formula

$$WCI = 13.12 + 0.6215 * TG - 11.37 * v^{+0.16} + 0.3965 * TG * v^{+0.16}$$

Where TG in celsius and v is wind speed in Km/h

References

Osczevski, Randall; Bluestein, Maurice (2005). The new wind chill equivalent temperature chart. Bulletin of the American Meteorological Society. 86 (10): 1453–1458

Examples

```
data(data_all)
wci(taverage = data_all$tg, w = data_all$wind)
```

wd *Warm days*

Description

Total numbers of days with TX higher than the 90th percentile.

Usage

```
wd(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	maximum temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Warm days

Examples

```
data(data_all)
wd(data=data_all$tx)
```

wki *Winkler index*

Description

Sum of degree days over 10 celsius of TG from April 1 until October 31

Usage

```
wki(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	medium temperature
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

Winkler index

References

Winkler, A.J., J.A. Cook, W.M. Kliewer, and L.A. Lider. 1974. General Viticulture. 4th ed. University of California Press, Berkeley.

Examples

```
data(data_all)
wki(data = data_all$tg)
```

`wn` *Warm nights*

Description

Percentages of days with TN higher than the 90th percentile.

Usage

```
wn(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

`data`	minimum temperature
`data_names`	names of each period of time
`time.scale`	month, season or year
`na.rm`	logical. Should missing values (including NaN) be removed?

Value

Warm nights

Examples

```
data(data_all)
wn(data=data_all$tn)
```

ws *Winter Severity*

Description

Mean TG of the coldest month of the year

Usage

```
ws(data, data_names = NULL, na.rm = FALSE, ...)
```

Arguments

data	medium temperature
data_names	names of each period of time
na.rm	logical. Should missing values (including NaN) be removed?
...	...

Value

Winter Severity index

Examples

```
data(data_all)
ws(data = data_all$tg)
```

wsd *Warm spell duration*

Description

Count of days with at least 6 consecutive days when TX > 90th percentile.

Usage

```
wsd(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	maximum temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Warm spell duration index

Examples

```
data(data_all)
wsd(data=data_all$tx)
```

---

xtg *Maximum TG*

Description

Maximum of daily mean air temperature

Usage

```
xtg(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	medium temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Average temperature

Examples

```
data(data_all)
xtg(data=data_all$tg)
```

xtn *Maximum TN*

Description

Maximum of daily minimum air temperature

Usage

```
xtn(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	minimum temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Average temperature

References

Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5. https://www.ecad.eu/documents/WCDMP_72_TD_1500_en_1.pdf

Examples

```
data(data_all)
xtn(data=data_all$tn)
```

xtx *Maximum TX*

Description

Maximum of daily maximum air temperature

Usage

```
xtx(data, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

data	maximum temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

Average temperature

References

Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5. https://www.ecad.eu/documents/WCDMP_72_TD_1500_en_1.pdf

Examples

```
data(data_all)
xtx(data=data_all$tx)
```

---

zcd *Zero crossing days*

Description

Number of days with TX > 0 Celsius and TN < 0 Celsius.

Usage

```
zcd(tmax, tmin, data_names = NULL, time.scale = YEAR, na.rm = FALSE)
```

Arguments

tmax	maximum temperature
tmin	minimum temperature
data_names	names of each period of time
time.scale	month, season or year
na.rm	logical. Should missing values (including NaN) be removed?

Value

zero crossing days

Examples

```
data(data_all)
zcd(tmax=data_all$tx, tmin=data_all$tn)
```