Package 'PowerSDI'

August 5, 2023

Type Package

Title Calculate Standardized Drought Indices Using NASA POWER Data

Version 1.0.0

Description A set of functions designed to calculate the standardized precipitation and standardized precipitation evapotranspiration indices using NASA POWER data. These indices are calculated using a reference data source. The functions verify if the indices estimates meet the normality assumption and how well NASA POWER estimates represent real world data. Indices are calculated in a routine mode. Potential evapotranspiration amounts and the difference between rainfall and potential evapotranspiration are also calculated. The functions adopt a basic time scale that splits each month into four periods. Days 1 to 7, days 8 to 14, days 15 to 21, and days 22 to 28, 29, 30, or 31. Where TS=4 corresponds to a 12-month length moving window (calculated 4 times a month) and TS=48 corresponds to a 1-month length moving window (calculated 4 times a month).

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Encoding UTF-8

LazyData true

RoxygenNote 7.2.3

Depends R (>= 2.10)

Imports graphics,
lmom,
nasapower,
stats,
utils

URL https://github.com/gabrielblain/PowerSDI

BugReports https://github.com/gabrielblain/PowerSDI/issues

Suggests testthat (>= 3.0.0)

Config/testthat/edition 3

R topics documented:

`Accuracy` *Calculate Scalar Measures of Accuracy*

Description

Calculates scalar measures of accuracy.

Usage

```
Accuracy(obs_est, conf.int = "Yes", sig.level = 0.95)
```

Arguments

`obs_est`	A 2-column matrix. The reference or observed and the estimated or predicted data. See `ObsEst` object as an example.
`conf.int`	A character variable (`Yes` or `No`) defining if the function must calculate confidence intervals. Default is "Yes".
`sig.level`	A numeric variable (between 0.90 and 0.95) defining the significance level for parameter the confidence intervals. Default is 0.95.

Value

An object of `PowerSDI.Accuracy`, a `list`, which reports:

- Absolute mean error (AME)
- Square root of the mean squared error (RMSE)
- Willmott's indices of agreement: original (dorig)
- Modified (dmod) and refined (dref)
- Pearson determination coefficient (R2), and
- If `conf.int="Yes"`, confidence intervals are calculated

Examples

```
data("ObsEst")
a <- Accuracy(obs_est = ObsEst, conf.int = "No")
a

# A generic plotting method is also supplied
plot(a)
```

DistPar *Parameters for Calculating the SDIs Provided by the ScientSDI Function*

Description

Contains parameters of the gamma and GEV distributions and the Pr(Rain=0).

Usage

```
DistPar
```

Format

A `data.frame` with 13 variables and 48 rows.

lon longitude in decimal degrees

lat latitude in decimal degrees

quart.month The quartile of each month

alfa.rain Shape parameter of the gamma distribution

beta.rain Scale parameter of the gamma distribution

probzero.rain Probability of rain=0

loc.harg Location parameter of the GEV distribution, PE calculated by HS method

sc.harg Scale parameter of the GEV distribution, PE calculated by HS method

sh.harg Shape parameter of the GEV distribution, PE calculated by HS method

loc.pm Location parameter of the GEV distribution, PE calculated by PM method

sc.pm Scale parameter of the GEV distribution, PE calculated by PM method

sh.pm Shape parameter of the GEV distribution, PE calculated by PM method

TS Time scale at which the SDIs will be calculated

Source

Generated by the `ScientSDI()` function using NASA POWER data.

Examples

```
data(DistPar)
```

ObsEst *Example Data of the Input Required by the Accuracy Function*

Description

Contains pairs of reference and estimated data.

Usage

```
ObsEst
```

Format

A `data.frame` with 2 variables and 1434 rows.

PE_obs PE data from a reference weather station

PE_est PE data from the NASA POWER project

Source

Generated by the PowerSDI package using data from NASA POWER and Agronomic Institute.

Examples

```
data(ObsEst)
```

OperatSDI *OperatSDI*

Description

Calculates the SPI and SPEI using a NASA POWER data.

Usage

```
OperatSDI(
  lon,
  lat,
  start.date,
  end.date,
  PEMethod = "HS",
  distr = "GEV",
  parms,
  TS = 4
)
```

Arguments

lon	longitude in decimal degrees.
lat	latitude in decimal degrees.
start.date	Date at each the calculation must start (“YYYY-MM-DD").
end.date	Date at each the calculation must end (“YYYY-MM-DD").
PEMethod	A character variable ("HS" or "PM") defining the potential evapotranspiration method. Default is "HS".
distr	A character variable ("GEV" or "GLO") defining which distribution is used to calculate the SPEI. Default is "GEV".
parms	Parameters required for calculating the SPI and SPEI. It is provided by the SciEntSDI function (DistPar).
TS	#’Time scale on the "quart.month" basis (integer values between 1 and 96).

Value

A data frame with Rainfall, potential evapotranspiration (PE), difference between rainfall and PE (in millimiters), the NASA-SPI and NASA_SPEI, and the SDI categories corresponding to each indices estimates.

Examples

```
data("DistPar")
 OperatSDI(lon = -47.3, lat = -22.67, start.date = "2023-06-01",
  end.date = "2023-06-30", parms = DistPar)
```

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plot.PowerSDI.Accuracy

Plots PowerSDI.Accuracy Objects

Description

Custom `plot()` method for `PowerSDI.Accuracy` objects.

Usage

```
## S3 method for class 'PowerSDI.Accuracy'
plot(x, ...)
```

Arguments

x	a ‘PowerSDI.Accuracy‘ object
...	Other parameters as passed to `plot()`

Value

Nothing. Side-effect: plots graphs.

PlotData *PlotData*

Description

Plots Rainfall and potential evapotranspiration amounts using NASA POWER data.

Usage

```
PlotData(lon, lat, start.date, end.date)
```

Arguments

lon	longitude in decimal degrees: (+) Eastern Hemisphere (-) Western Hemisphere.
lat	latitude in decimal degrees: (+) Northern Hemisphere (-) Southern Hemisphere.
start.date	date at which the indices estimates should start ("YYYY-MM-DD").
end.date	date at which the indices estimates should end ("YYYY-MM-DD").

Value

Scatter plots of Rainfall and potential evapotranspiration accumulated at the 1-quart.month time scale.

Examples

```
PlotData(lon = -47.3, lat = -22.87, start.date = "2021-12-28", end.date = "2022-12-31")
```

print.PowerSDI.Accuracy
Prints PowerSDI.Accuracy Objects

Description

Custom `print()` method for `PowerSDI.Accuracy` objects.

Usage

```
## S3 method for class 'PowerSDI.Accuracy'
print(x, digits = max(3L, getOption("digits") - 3L), ...)
```

Arguments

x	a `PowerSDI.Accuracy` object
digits	The number of digits to be used after the decimal when displaying accuracy values.
...	ignored

Reference *Reference*

Description

Calculates the SPI and SPEI using a reference data source.

Usage

```
Reference(ref, distr = "GEV", PEMethod = "HS", TS = 4)
```

Arguments

ref	A data frame with the variables required for calculating the SDIs. See refHS or refPM as examples.
distr	A character variable ("GEV" or "GLO") defining which distribution is used to calculate the SPEI. Default is "GEV".
PEMethod	A character variable ("HS" or "PM") defining the potential evapotranspiration method. Default is "HS".
TS	Time scale on the quart.month" basis (integer values between 1 and 96). Default is 4.

Value

A data frame with: Rain, potential evapotranspiration, Difference between rainfall and potential evapotranspiration, SPI and SPEI calculated at the time scale selected by the user.

Examples

```
data("refHS")
Reference(ref = refHS, distr = "GEV", PEMethod = "HS", TS = 4)
```

refHS *Example of the Input Required by the Reference Function*

Description

Contains data for calculating the SPI and SPEI.

Usage

```
refHS
```

Format

A `data.frame` with 10950 rows and 8 variables.

YEAR Year

MM Month

DD Day

tmed Daily average air temperature at 2 meters above the ground (degrees C)

tmax Daily maximum air temperature at 2 meters above the ground (degrees C)

tmin Daily minimum air temperature at 2 meters above the ground (degrees C)

Ra Daily top of the atmosphere radiation (MJ/m^2/day)

Rain Daily rainfall amounts (mm)

Source

Agronomic Institute and NASA POWER.

Examples

```
data(refHS)
```

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refPM *Example of the Input Required by the Reference Function*

Description

Contains data for calculating the SPI and SPEI.

Usage

```
refPM
```

Format

A `data.frame` with 10958 rows and 11 variables.

YEAR Year

MM Month

DD Day

tmed Daily average air temperature at 2 meters above the ground (degrees C)

tmax Daily maximum air temperature at 2 meters above the ground (degrees C)

tmin Daily minimum air temperature at 2 meters above the ground (degrees C)

Ra Daily top of the atmosphere radiation (MJ/m^2/day)

Rs Daily global horizontal irradiance (MJ/m^2/day)

W Daily average wind speed at 2 meters above the ground (m/s)

RH Daily average relative humidity at 2 meters above the ground (in percentage)

Rain Daily rainfall amounts (mm)

Source

Agronomic Institute and NASA POWER.

Examples

```
data(refPM)
```

`ScientSDI` *ScientSDI*

Description

Verifies concepts expected from SDI.

Usage

```
ScientSDI(
  lon,
  lat,
  start.date,
  end.date,
  distr = "GEV",
  TS = 4,
  Good = "Yes",
  sig.level = 0.95,
  RainUplim = NULL,
  RainLowlim = NULL,
  PEUplim = NULL,
  PELowlim = NULL
)
```

Arguments

`lon`	longitude in decimal degrees: (+) Eastern Hemisphere (-) Western Hemisphere.
`lat`	latitude in decimal degrees: (+) Northern hemisphere (-) Southern Hemisphere.
`start.date`	date at which the indices estimates should start. Format: YYYY-MM-DD".
`end.date`	date at which the indices estimates should end. Format: YYYY-MM-DD".
`distr`	A character variable ("GEV" or "GLO") defining the distribution to calculate the SPEI. Default is "GEV".
`TS`	Time scale on the quart.month basis (integer values between 1 and 96). Default is 4.
`Good`	A character variable ("Yes" or "No") to calculate or not the goodness-of-fit and normality tests. Default is "Yes".
`sig.level`	A numeric variable (between 0.90 and 0.95) defining the significance level for parameter Good. Default is "0.95".
`RainUplim`	Optional. Upper limit in millimeters from which rainfall values larger than it will be removed. Default is NULL.
`RainLowlim`	Optional. Lower limit in millimeters from which rainfall values smaller than it will be removed. Default is NULL.

PEUplim	Optional. Upper limit in millimeters from which evapotranspiration values larger than it will be removed. Default is NULL.
PELowlim	Optional. Lower limit in millimeters from which evapotranspiration values smaller than it will be removed. Default is NULL.

Value

A list with data calculated at the time scale selected by the user. If Good="Yes", this list includes: SDI: The NASA-SPI, NASA-SPEI.HS and NASA-SPEI.PM. DistPar: The parameters of the distributions (gamma and GEV) used to calculate the indices. GoodFit: The Lilliefors and Anderson-Darling tests goodness-of-fit tests. Normality: The outcomes of the two normality checking procedures (Wu et al., 2007 and Stagge et., 2015). If Good="No", this list includes SDI and DistPar. This function also presents other data (in millimiters) calculated from the NASA POWER project: Rainfall amounts (Rain). Potential evapotranspiration values estimated through the Hargreaves and Samani method (PEHS). Potential evapotranspiration values estimated through the FAO-56 Penman-Monteith method (PEPM). The difference between rainfall and potential evapotranspiration (PPEHS and PPEPM).

Examples

```
ScientSDI(lon=-47.3, lat=-22.87, start.date="2015-01-01", end.date="2022-12-31", TS=1,
Good="no")
```

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