Package ‘spdownscale’

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Type Package

Title Spatial Downscaling Using Bias Correction Approach

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Description Spatial downscaling of climate data (Global Circulation Models/Regional Climate Models) using quantile-quantile bias correction technique.

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LazyData TRUE

Imports stats, graphics

Depends R (>= 2.10)

RoxygenNote 5.0.1

NeedsCompilation no

Repository CRAN

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data_model

Description

EC-EARTH (GCM) rainfall data at the Gold Coast Seaway meteorological station, Australia (station number - 40764, Period- 1/1/2000 to 12/31/2012, Latitude/longitude - -27.9390/153.4283)

Usage

data_model

Format

A data.frame of time and precipitation in mm for every 3h interval.

data_model_future

Description

EC-EARTH (GCM) future (RCP 4.5) rainfall data at the Gold Coast Seaway meteorological station, Australia (station number - 40764, Period- 1/1/2026 to 12/31/2045, Latitude/longitude - -27.9390/153.4283)

Usage

data_model_future

Format

A data.frame of time and precipitation in mm for every 3h interval.
**data_observation**

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**Description**

Observational rainfall data at the Gold Coast Seaway meteorological station, Australia (station number - 40764, Period- 1/4/2000 to 12/31/2012, Latitude/longitude - -27.9390/153.4283)

**Usage**

data_observation

**Format**

A data.frame of time and precipitation in mm for every 3h interval

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**downscale**

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**Spatial Downscaling**

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**Description**

Generating the future climate data (rainfall)

**Usage**

downscale(obs_c, mod_c, obs_v, mod_v, mod_fut)

**Arguments**

- obs_c: vector of observational climate data (rainfall) used for calibrating the model
- mod_c: vector of GCM/RCM rainfall data (rainfall) used for calibrating the model
- obs_v: vector of observational climate data (rainfall) used for validating the model
- mod_v: vector of GCM/RCM climate data (rainfall) used for validating the model
- mod_fut: vector of GCM/RCM future climate data (rainfall) need to be downscaled

**Details**

1) Dry-days correction / Defining threshold values

The relationship between the cumulative frequencies (thresholds) corresponding to the dry days of GCM/RCM data and that of the observational data is defined by a polynomial function given by:

\[
\text{threshold}_\text{obs} = (\text{threshold}_\text{mod})^n
\]

\[
n = \ln(\text{threshold}_\text{obs}_c) / \ln(\text{threshold}_\text{mod}_c)
\]

2) wet-days correction / Correcting the intensity of the GCM/RCM data
Two parameter (shape and scale factors) gamma distribution function is used to model the frequency distributions of the rainfall data. The GCM/RCM rainfall above the threshold were corrected using unique correction factors for different cumulative frequencies.

\[
\text{corrected}_{\text{mod fut}} = \frac{\text{mod fut} \times F^{-1}(F(\text{mod fut},\text{sh obs c,sc obs c})/F^{-1}(F(\text{mod fut},\text{sh mod c,sc mod c}))}{F^{-1}(F(\text{mod fut},\text{sh mod c,sc mod c})}
\]

where obs - observational data; mod - GCM/RCM data; n - constant; c - calibration; v - validation; fut - future data; sh - shape factor; sc - scale factor; F. - cumulative density function and F-1 - inverse of cumulative density function

**Examples**

```r
# subsetting dat_model
mod_calibration=subset(data_model,(year==RPP3|year==RPP5|year==RPP7|year==RPP9|year==RP11))
mod_validation=subset(data_model,(year==RPP4|year==RPPV|year==RPP8|year==RP1P|year==RP1R))
# subsetting data_observation
obs_calibration=subset(data_observation,(year==RPP3|year==RPP5|year==RPP7|year==RPP9|year==RP11))
obs_validation=subset(data_observation,(year==RPP4|year==RPPV|year==RPP8|year==RP1P|year==RP1R))
# creating the input vectors
obs_c=obs_calibration$pr
mod_c=mod_calibration$pr
obs_v=obs_validation$pr
mod_v=mod_validation$pr
mod_fut= data_model_future$pr

downscale(obs_c,mod_c,obs_v,mod_v,mod_fut)
```

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### ParaCal

**Calibration Parameters**

**Description**

Displays the shape factors, scale factors and the threshold values of the observation and GCM/RCM data set which ultimately define the model.

**Usage**

```r
ParaCal(obs_c, mod_c, obs_v, mod_v, mod_fut)
```

**Arguments**

- `obs_c`: vector of observational climate data (rainfall) used for calibrating the model
- `mod_c`: vector of GCM/RCM climate data (rainfall) used for calibrating the model
- `obs_v`: vector of observational climate data (rainfall) used for validating the model
- `mod_v`: vector of GCM/RCM climate data (rainfall) used for validating the model
- `mod_fut`: vector of GCM/RCM future climate data (rainfall) need to be downscaled
Details

1) Dry-days correction / Defining threshold values

The relationship between the cumulative frequencies (thresholds) corresponding to the dry days of GCM/RCM data and that of the observational data is defined by a polynomial function given by:

\[ \text{threshold}_{\text{obs}} = (\text{threshold}_{\text{mod}})^n \]

\[ n = \frac{\ln(\text{threshold}_{\text{obs}}_c)}{\ln(\text{threshold}_{\text{mod}}_c)} \]

2) wet-days correction / Correcting the intensity of the GCM/RCM data

Two parameter (shape and scale factors) gamma distribution function was used to model the frequency distributions of the rainfall data. The GCM/RCM rainfall above the threshold were corrected using unique correction factors for different cumulative frequencies.

\[ \text{corrected}_{\text{mod, fut}} = \text{mod, fut} \times F^{-1}(F(\text{mod, fut}, \text{sh}_{\text{obs, c}}, \text{sc}_{\text{obs, c}})/F(\text{mod, fut}, \text{sh}_{\text{mod, c}}, \text{sc}_{\text{mod, c}})) \]

where obs - observational data; mod - GCM/RCM data; n - constant; c - calibration; v - validation; fut - future data; sh - shape factor; sc - scale factor; F - cumulative density function and F^{-1} - inverse of cumulative density function

Examples

```r
#subsetting dat_model
  mod_validation=subset(data_model,(year==2004|year==2006|year==2008|year==2010|year==2012))

#subsetting data_observation
  obs_validation=subset(data_observation,(year==2004|year==2006|year==2008|year==2010|year==2012))

#creating the input vectors
  obs_c=obs_calibration$pr
  mod_c=mod_calibration$pr
  obs_v=obs_validation$pr
  mod_v=mod_validation$pr
  mod_fut= data_model_future$pr

  ParaCal(obs_c,mod_c,obs_v,mod_v,mod_fut)
```

<table>
<thead>
<tr>
<th>ResVal</th>
<th>Validation Summary</th>
</tr>
</thead>
</table>

Description

Displays the summary of the validation.

Usage

ResVal(obs_c, mod_c, obs_v, mod_v, mod_fut)
Arguments

- obs_c: vector of observational climate data (rainfall) used for calibrating the model
- mod_c: vector of GCM/RCM climate data (rainfall) used for calibrating the model
- obs_v: vector of observational climate data (rainfall) used for validating the model
- mod_v: vector of GCM/RCM climate data (rainfall) used for validating the model
- mod_fut: vector of GCM/RCM future climate data (rainfall) used to be downscaled

Details

1) Dry-days correction / Defining threshold values

The relationship between the cumulative frequencies (thresholds) corresponding to the dry days of GCM/RCM data and that of the observational data is defined by a polynomial function given by:

\[ \text{threshold}_\text{obs} = (\text{threshold}_\text{mod})^n \]

\[ n = \frac{\ln(\text{threshold}_\text{obs}_c)}{\ln(\text{threshold}_\text{mod}_c)} \]

2) wet-days correction / Correcting the intensity of the GCM/RCM data

Two parameter (shape and scale factors) gamma distribution function was used to model the frequency distributions of the rainfall data. The GCM/RCM rainfall above the threshold were corrected using unique correction factors for different cumulative frequencies.

\[ \text{corrected}_\text{mod}_\text{fut} = \text{mod}_\text{fut} \times F^{-1}(F(\text{mod}_\text{fut}, \text{sh}_\text{obs}_c, \text{sc}_\text{obs}_c)/F^{-1}(F(\text{mod}_\text{fut}, \text{sh}_\text{mod}_c, \text{sc}_\text{mod}_c) \]

where obs - observational data; mod - GCM/RCM data; n - constant; c - calibration; v - validation; fut - future data; sh - shape factor; sc- scale factor; F. - cumulative density function and F-1 - inverse of cumulative density function

Examples

```r
#subsetting dat_model
mod_validation=subset(data_model,(year==2004|year==2006|year==2008|year==2010|year==2012))
#subsetting data_observation
obs_validation=subset(data_observation,(year==2004|year==2006|year==2008|year==2010|year==2012))
#creating the input vectors
obs_c=obs_calibration$pr
mod_c=mod_calibration$pr
obs_v=obs_validation$pr
mod_v=mod_validation$pr
mod_fut=data_model_future$pr

ResVal(obs_c,mod_c,obs_v,mod_v,mod_fut)
```
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