Package ‘ClimateNAr’

April 25, 2025

Version 3.1.0

Title The R version of ClimateNA and some related functions

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Description The R version of ClimateNA has the following advantages: 1) runs faster for big datasets (>5 times); 2) can use DEM raster in TIFF format; 3) the output variables can be customized. Several related functions are included, such as raster stacking, API version access, desktop CMDline, and variable scanning.

System Requirements ClimateBC or ClimateNA installed for CMD Line access.

URL https://climatena.ca/downloads/ClimateNAr.zip

R topics documented:

Package installation

The ClimateNAr R package is not registered in CRAN. It needs to be downloaded and installed locally. The package can be installed locally in one of the three options:

1. Through R console interface: Packages => Install package(s) from local files.
2. Through RStudio: Tools => Install Packages => Install from: Package Archive Files (.zip; .tar.gz)
3. Through R code: install.packages('path/ClimateNAr.zip', repos=NULL). For example: install.packages('C:/temp/ClimateNAr.zip', repos=NULL)
4. Simply unzip *ClimateNAr.zip* to the R library folder on your computer.

R Functions

ClimateNAr

Description

ClimateNAr is an R version of ClimateNA that generates scale-free climate data for historical and future periods. The input file can be a CSV file (or a data frame) or a DEM raster file (either in TIFF or ASCII format) in latitude and longitude projection. The output variables can be customized. A full list of the climate variables can be found on the ClimateNA website. C*limateNAr* runs much faster but uses much more memory (RAM) than the desktop version. Thus, the size of the input file, which can be processed, depends on the size of your computer's memory.

Usage

ClimateNAr(inputFile, periodList, varList, outDir)

Arguments

inputFile	The full name of the input file. It can be either in CSV or raster (.tif or .asc) format. The raster must be in latitude-longitude projection (WGS84). The inputFile can also be a data frame. A CSV file or a data frame must have five columns in the following order: ID1, ID2, lat, lon, and elevation in the given order.
periodList	A list of periods to generate climate variables. It can be a single period or a list of periods. They can be either historical or future, such as periodList= c('Normal_1961_1990.nrm','Year_1902.ann','8GCMs_ensemble_ssp245_2041-2070.gcm'). The periodList can also be a range, such as, periodList=1941:1965 between 1941-1965. The periodList can be periodList= '8GCM_ssp245_2031' or periodList= '8GCM_ssp245_2031:2041'.
varList	A list of climate variables to generate, for example, varList=c('MAT','MAP'); or varList='Y' ('S' or 'M') for all annual variables (all seasonal or monthly variables), or varList='YS' for both annual and seasonal variables, varList='YSM' for all variables.
outDir	The folder to save the output files.

Examples

```
library(ClimateNAr)

#using a CSV input file
inputFile = 'C:/temp/test.csv'
```

```
varList=c('MAT','MAP','DD5','Tmax_sm','Tmax01') # or varList='YS'
periodList=
c('Normal_1961_1990.nrm','Year_1902.ann','8GCMs_ensemble_ssp245_2041-
2070.gcm')
outDir= 'C:/temp/'
test <- ClimateNAr(inputFile,periodList,varList,outDir); test


#using a TIFF or ASCII DEM raster file
inputFile = 'C:/temp/na20k.tif'
varList=c('MAT','MAP','DD5','Tmax_sm','Tmax01') # or varList='YS'
periodList=
c('Normal_1961_1990.nrm','Year_1902.ann','8GCMs_ensemble_ssp245_2041-
2070.gcm')
outDir= 'C:/temp/'
test <- ClimateNAr(inputFile,periodList,varList,outDir); test
```

ClimateNA_cmdLine

Description

ClimateNA_cmdLine is to run ClimateBC or ClimateNA using CMD Line feature in R, which allows integrating the climate models into a programming workflow. It can use most of the features of ClimateBC/NA. In addition, if this function is used to generate climate data in raster format (.asc), it also converts the .asc files into georeferenced .tif files with lat/lon projection (WGS84) and reduces the file size substantially.

Usage

ClimateNA_cmdLine <- function(exe = "ClimateNA_v7.60.exe", wkDir, period = 'Normal_1961_1990.nrm', MSY = 'Y', inputFile, outputFile)

Arguments

exe	The .exe file. It can be "ClimateNA_v7.60.exe" or "ClimateBC_v7.60.exe" the default value is "ClimateNA_v7.60.exe".
wkDir	The root directory of ClimateNA or ClimateBC in a format of "C:\\Climatena_v742\\". Please make sure to use double backslashes (\\) in the path.
Period	The period of the climate data. The default is "Normal_1961_1990.nrm". It can also be another historical normal (.nrm), decadal (e.g., "Decade_2001_2010.dcd"), annual (e.g., "Year_2021.ann"), and future period (.gcm).
MSY	The time scale of the climate variables. The default is 'Y' for annual variables. It can also be 'M' for monthly, 'S' for seasonal, 'SY' for annual and seasonal, or 'MSY' for all.
inputFile	The input file name and location. It can be either a .csv or .asc file, like: 'C:\\Climatena_v760\\InputFiles\\input_test.csv' or 'C:\\ClimateModels\\Climatena_v760\\InputFiles\\na50k.asc'.
outputFile	The output file name and location. It depends on the type of input file. If the input file is a .csv file, the output file should also be a .csv file, like: 'C:\\ClimateModels\\Climatena_v760\\test\\test_Normal_1961_1990.csv'. If the inputFile is an .asc file, the outputFile is a folder name like: 'C:\\Climatena_v760\\test\\'.

Examples

```
library(ClimateNAr)
wkDir = 'C:\\ClimateModels\\Climatena_v760\\'
exe <- "ClimateNA_v7.60.exe"

# Using a CSV file as the input file
inputFile = 'C:\\Climatena_v760\\InputFiles\\input_test.csv'
outputFile = 'C:\\ Climatena_v760\\test\\test_Normal_1961_1990.csv'
period = 'Normal_1961_1990.nrm'
ClimateNA_cmdLine(exe, wkDir, period, MSY='Y',inputFile, outputFile)

# Using an ASC raster file as the input file
inputFile = 'C:\\Climatena_v760\\InputFiles\\na50k.asc'
outputFile = 'C:\\Climatena_v760\\test\\'
period = 'Normal_1961_1990.nrm'
ClimateNA_cmdLine(exe,wkDir,period,MSY='SY',inputFile, outputFile)

# Using a loop to generate climate data for time-series
inputFile = 'C:\\Climatena_v760\\InputFiles\\na50k.asc'
outputFile = 'C:\\Climatena_v760\\test\\'
for(yr in 1961:1990){
      period = paste0('Year_', yr, '.ann')
      ClimateNA_cmdLine(exe,wkDir,period,MSY='SY',inputFile, outputFile)
}
```

ClimateNA_API

Description

ClimateNA_API is to get climate variables for a single location from ClimateBC or ClimateNA web API.

Usage

ClimateNA_API(ClimateBC_NA='NA', latLonEl, period='Normal_1961_1990.nrm', MSY='Y')

Arguments

ClimateBC_NA	To specify either to use ClimateBC or ClimateNA web API. The default is ClimateBC_NA = 'NA' for ClimateNA. It can also be ClimateBC_NA = 'BC' for ClimateBC.
latLonEl	Coordinates and elevation of a location, for example: latLonEl <- c(48.98,-115.02,200).
period	The period of the climate data. The default is 'Normal_1961_1990.nrm'. It can also be another historical or future period. Most period options of the desktop version are available.
MSY	The time scale of the climate variables. The default is 'Y' for annual variables. It can also be 'M' for monthly, 'S' for seasonal, 'SY' for annual and seasonal, or 'MSY' for all.

Limitations

All computing process occurs on the server for requests from all users and can easily crash the server. To prevent from using this function loops, the number of requests cannot be more than 2 times per second.

Examples

```
>library(ClimateNAr)
>latLonEl <- c(48.98,-115.02,1000)
>clm <- ClimateNA_API(ClimateBC_NA='BC',latLonEl,period='Normal_1961_1990.nrm',MSY='Y');
>clm <- ClimateNA_API(ClimateBC_NA='NA',latLonEl,period='Year_2011.ann',MSY='Y');
>clm <- ClimateNA_API(ClimateBC_NA='BC',latLonEl,period='8GCMs_ensemble_ssp245_2041-
2070.gcm',MSY='Y');

>head(clm);dim(clm)
```

ClimateNA_API2

Description

ClimateNA_API2 is to get climate variables for multiple locations from ClimateBC or ClimateNA web API.

Usage

ClimateNA_API2(ClimateBC_NA='NA', inputFile, period='Normal_1961_1990.nrm', MSY='Y');

Arguments

ClimateBC_NA	To specify either to use ClimateBC or ClimateNA web API. The default is ClimateBC_NA = 'NA' for ClimateNA. It can also be ClimateBC_NA = 'BC' for ClimateBC.
inputFile	An .CSV input file consists of coordinates and elevation of locations. It has the same format as the .CSV input file for desktop ClimateBC or ClimateNA.
period	The period of the climate data. The default is 'Normal_1961_1990.nrm'. It can also be another historical or future period. Most period options of the desktop version are available.
MSY	The time scale of the climate variables. The default is 'Y' for annual variables. It can also be 'M' for monthly, 'S' for seasonal, 'SY' for annual and seasonal, or 'MSY' for all.

Limitations

All computing process occurs on the server for requests from all users and can easily crash the server. To prevent this, a two-way throttling measure is implemented. First, the input file *x* cannot have more than 100 entries. Second, the number of requests cannot be more than 10 times per hour and 100 times per day.

Examples

```
>library(ClimateNAr)
>input_file <- 'C:/temp/locations.csv'
>clm <- ClimateNA_API2 (ClimateBC_NA='NA', inputFile=input_file,
period='Normal_1961_1990.nrm',MSY='Y');
>head(clm);dim(clm)
```

rasterDownload

Description

rasterDownload is to download raster files for specific variables for BC, WNA, or NA generated by ClimateBC and ClimateNA (available for selected periods and climate change scenarios).

Usage
rasterDownload (region='BC',res='800m',period='Normal_1961_1990',varList=varList,sDir='C:/temp')

Arguments

region	The region of interest. It can be 'BC', 'WNA' or 'NA'.
res	Spatial resolution. The default is '800m'. The '800m' is available for 'BC' and 'WNA', and the '4000m' is available for NA.
period	The period of the climate data. The default is "Normal_1961_1990". The available options include: "Normal_1971_2000", "Normal_1981_2010", and "Normal_1991_2020" for historical periods, all the 8GCMs_ensembles (for example: "8GCMs_ensemble_ssp126_2011-2040"). More options may be added later on.
varList	A list of climate variables to download.
sDir	The directory to be created to save the downloaded files.

Examples
```
library(ClimateNAr)
varList <- c('mat', 'map','td')
rasterDownload(region='BC',res='800m',
period='Normal_1961_1990',varList=varList,sDir='C:/temp')
```

rasterStack

Description
rasterStack is to generate a raster stack from raster files for model spatial predictions.

Usage
rasterStack(wd, varList, rType='tif')

Arguments

wd	The working directory where the raster files are located.
varList	A list of variables to be included in the stack.
rType	Raster type of the raster files. The default is Tiff files ('tif'). It can also be ArcGIS grid files ('grid').

Examples
```
library(ClimateNAr)
wd <- 'C:/temp/Normal_1961_1990SY/'
varList <- c('mat', 'map', 'td')
stk <- rasterStack(wd,varList,rType='tif');stk

#Please check the file location to make sure the 'wd' is correctly
specified.
```

tifToAsc

Description

tifToAsc converts a DEM raster from TIFF to ASCII format that can be used as an input file for ClimateNA. The TIFF file must be in lat/lon projection.

Usage
tifToAsc (tifFile, ascFile)

Arguments

tifFile	the full name of the tif raster, for example, 'C:/temp/bc80k.tif'.
ascFile	the full name of the ascii file, for example, 'C:/temp/bc80k.asc'

Examples
```
library(ClimateNAr)
tifFile = 'C:/temp/bc80k.tif'
ascFile = 'C:/temp/bc80k.asc'
tifToAsc (tifFile, ascFile)
```

varScan

Description
varScan is to identify the best climate variables, either individually or in combinations, as predictors in quadratic form for a dependent variable.

Usage
varScan(x, y, varComb = 1, smVar = 0, IR = F, title = "3D chart")

Arguments

x	A dataframe comprising climate variables (in columns) to be scanned.
y	A vector for a dependent variable.
varComb	The number of variables combined. varComb=1 for a single variable (default), varComb=2 for a combination of 2 variables (up to 4 variables).
smVar	The number of top single variables selected for scanning multiple regressions. smVar=0 to scan all variables (default); smVar=5 to scan top 5 single variables.
IR	Considering interactions. IR=False for no interaction considered (Default)
title	The title of the output plot
Value	The model for the best climate variable combinations and a list of sorted variables based on their importance.

Examples
```
>library(ClimateNAr)
>xy <- read.csv('C:/temp/Normal_1961_1990Y.csv');head(xy)
>x <- xy[,1:24]; head(x)
>y = xy$TD;y
>bestMod <- varScan(x, y, varComb=1, smVar=10,IR=F,title='Y values');
>head(bestMod$list,10)
```

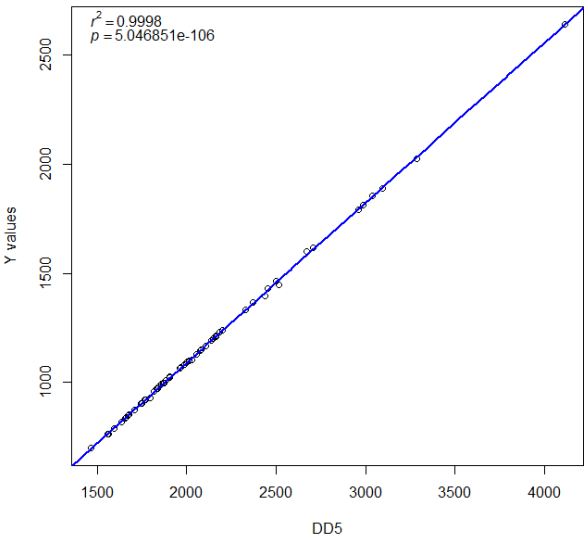
```
Call:
lm(formula = fmla, data = x)

Residuals:
     Min       1Q   Median       3Q      Max
-22.4533  -1.6381   0.5627   2.8155  13.6033

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -3.866e+02  1.152e+01 -33.563   <2e-16 ***
DD5          7.411e-01  9.490e-03  78.094   <2e-16 ***
I(DD5^2)    -1.407e-06  1.857e-06  -0.758    0.452
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 5.544 on 58 degrees of freedom
Multiple R-squared:  0.9998,    Adjusted R-squared:  0.9998
F-statistic: 1.239e+05 on 2 and 58 DF,  p-value: < 2.2e-16

> head(bestMod$list,10)
    var1 r2_adj       P-value      sgma      aic
1    DD5 0.9998 5.046851e-106  5.544401 386.9944
2   DD18 0.9984  2.878871e-82 14.237847 502.0545
3   MWMT 0.9910  1.614096e-60 33.761523 607.3915
4    MAT 0.9847  8.650413e-54 44.100258 639.9830
5  DD_18 0.9775  5.976794e-49 53.441618 663.4222
6   Eref 0.9601  1.018799e-41 71.213561 698.4476
7    EMT 0.9552  2.911958e-40 75.451490 705.5000
8    FFP 0.9546  4.260594e-40 75.948213 706.3005
9   eFFP 0.9412  7.739725e-37 86.439376 722.0863
10  bFFP 0.9391  2.093432e-36 87.935087 724.1793
>
```




```
>bestMod <- varScan(x, y, varComb=2, smVar=10,IR=F,title='Y values');
>head(bestMod$list,10)
```

```
Call:
lm(formula = fmla, data = x2)

Residuals:
    Min      1Q  Median      3Q     Max
-8.3518 -2.0959  0.1705  1.9276  7.2036

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -4.159e+02  4.397e+01  -9.460 3.28e-13 ***
DD5          8.337e-01  4.347e-02  19.180  < 2e-16 ***
DD18         2.740e-01  6.337e-02   4.324 6.37e-05 ***
I(DD5^2)    -6.062e-05  9.483e-06  -6.392 3.48e-08 ***
I(DD18^2)    2.787e-04  5.595e-05   4.981 6.41e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.329 on 56 degrees of freedom
Multiple R-squared:  0.9999,    Adjusted R-squared:  0.9999
F-statistic: 1.719e+05 on 4 and 56 DF,  p-value: < 2.2e-16

> head(bestMod$list,10)
   var1  var2 r2_adj       P-value     sgma      aic
1   DD5  DD18 0.9999 9.231846e-114 3.329271 326.6296
2   DD5  MWMT 0.9999 2.146934e-107 4.325513 358.5664
3   DD5   EMT 0.9999 5.144599e-115 3.161967 320.3394
4   DD5  eFFP 0.9999 2.090475e-110 3.821724 343.4592
5   DD5   MAT 0.9998 2.476952e-104 4.905895 373.9270
6   DD5 DD_18 0.9998 2.673138e-105 4.714679 369.0767
7   DD5  Eref 0.9998 1.243151e-103 5.049276 377.4415
8   DD5   FFP 0.9998 6.979768e-107 4.417544 361.1349
9   DD5  bFFP 0.9998 2.674080e-103 5.118814 379.1102
10 DD18  MWMT 0.9994  1.138076e-89 8.964938 447.4788
>
```