

Package ‘pRecipe’

April 22, 2022

Title A Multiscale Framework for Data Analysis of Global Precipitation

Version 0.2.0

Description

An open-access tool/framework to download, validate, visualize, and analyze multi-source precipitation data across various spatio-temporal scales. Ultimately providing the hydrology science community with the tools for consistent and reproducible analysis regarding precipitation.

Depends R (>= 4.0.0)

Imports curl, data.table, dplyr, getPass, ggplot2, hdf5r, lubridate, methods, ncd4, parallel, raster, rgdal, R.utils, sf, sp, stats, stringr, utils, viridis, zoo

License GPL-3

Encoding UTF-8

URL <https://github.com/MiRoVaGo/pRecipe>

BugReports <https://github.com/MiRoVaGo/pRecipe/issues>

SystemRequirements PROJ (>= 4.8.0, <https://proj.org/download.html>) and GDAL (>= 1.11.4, <https://gdal.org/download.html>).

RoxygenNote 7.1.2

Suggests rmarkdown, knitr, spelling, testthat (>= 3.0.0)

Config/testthat/edition 3

Language en-US

VignetteBuilder knitr

NeedsCompilation no

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Repository CRAN

Date/Publication 2022-04-22 08:40:02 UTC

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<code>create_folders</code>	<i>Directory creator</i>
-----------------------------	--------------------------

Description

Function for creating tidy folders to store pRecipe.

Usage

```
create_folders(destination)
```

Arguments

`destination` a character string with the path where the folders will be created as follows:

- `destination/data`
 - `destination/data/database`
 - `destination/data/raw`
 - * `destination/data/raw/20cr`
 - * `destination/data/raw/cmap`
 - * `destination/data/raw/...`

Value

No return value, called to create tidy directories for pRecipe.

<code>crop_data</code>	<i>Crop precipitation data sets</i>
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Description

The function `crop_data` crops the data sets using a shapefile mask.

Usage

```
crop_data(x, shp_path)
```

Arguments

`x` a pRecipe `data.table` imported using `import_full_data` or `import_subset_data`.
`shp_path` a character string with the path to the ".shp" file.

Value

a data.table with the cropped data sets

Examples

```
## Not run:  
x <- import_full_data(c("cru_ts", "cpc", "ghcn", "gpcp"), tempdir())  
w <- crop_data(x, "cze.shp")  
y <- import_subset_data(c("cru_ts", "cpc", "ghcn", "gpcp"), 2000, 2009,  
c(12.24, 48.56, 18.85, 51.12), tempdir())  
z <- crop_data(y, "cze.shp")  
  
## End(Not run)
```

display_data	<i>Display available data sets</i>
--------------	------------------------------------

Description

Function for displaying available data sets in pRecipe.

Usage

```
display_data()
```

Value

a data.frame listing the data sets pRecipe is able to work with.

download_20cr	<i>20CR data downloader</i>
---------------	-----------------------------

Description

Function for downloading 20CR NC files.

Usage

```
download_20cr(folder_path)
```

Arguments

folder_path a character string with the path where the "raw" folder is located.

Value

No return value, called to download the data set.

download_all	<i>All data downloader</i>
--------------	----------------------------

Description

Function for downloading GPCP NC file.

Usage

```
download_all(folder_path)
```

Arguments

folder_path a character string with the path where the "raw" folder is located.

Value

No return value, called to download the data set.

download_cmap	<i>CMAP data downloader</i>
---------------	-----------------------------

Description

Function for downloading CMAP NC files.

Usage

```
download_cmap(folder_path)
```

Arguments

folder_path a character string with the path where the "raw" folder is located.

Value

No return value, called to download the data set.

download_cpc	<i>CPC data downloader</i>
--------------	----------------------------

Description

Function for downloading CPC-GLOBAL NC files.

Usage

```
download_cpc(folder_path, start_year = 1979, end_year = 2021)
```

Arguments

folder_path	a character string with the path where the "raw" folder is located.
start_year	numeric. Start year should be between 1979-2021.
end_year	numeric. End year should be between 1979-2021, and should be greater or equal to start year.

Value

No return value, called to download the data set.

download_cru_ts	<i>CRU data downloader</i>
-----------------	----------------------------

Description

Function for downloading CRU_TS NC.GZ file.

Usage

```
download_cru_ts(folder_path)
```

Arguments

folder_path	a character string with the path where the "raw" folder is located.
-------------	---

Value

No return value, called to download the data set.

download_data	<i>Download and import precipitation data from various sources</i>
---------------	--

Description

The function `download_data` downloads the selected data product.

Usage

```
download_data(name = "all", project_folder_path = ".", reformat = TRUE)
```

Arguments

<code>name</code>	a character string with the name(s) of the desired data set. Suitable options are: <ul style="list-style-type: none"> • "all" for all of the below listed data sets (default), • "20cr" for 20CR v3, • "cmap" for CMAP standard version, • "cpc" for CPC-Global, • "cru_ts" for CRU_TS v4.05, • "ghcn" for GHCN-M v2 • "gpcc" for GPCC v2018, • "gpcp" for GPCP v2.3, • "gpm_imergm" for GPM IMERG Final v06, • "ncep_ncar" for NCEP/NCAR, • "ncep_doe" for NCEP/DOE, • "precl" for PRECL, • "trmm_3b43" for TRMM 3B43 v7, • "udel" for UDEL v501.
<code>project_folder_path</code>	a character string with the path where pRecipe will be hosted. Inside it the required subfolders will be created see create_folders
<code>reformat</code>	logical. If TRUE (default) the downloaded data sets are reformatted into <code>data.table</code> and stored in <code>.Rds</code> files. See reformat_data

Value

No return value, called to download the required data sets.

Examples

```
download_data(c("cmap", "ghcn", "gpcp"), tempdir(), reformat = FALSE)
```

download_ghcn	<i>GHCN-M data downloader</i>
---------------	-------------------------------

Description

Function for downloading GHCN-M NC file.

Usage

```
download_ghcn(folder_path)
```

Arguments

folder_path a character string with the path where the "raw" folder is located.

Value

No return value, called to download the data set.

download_gpcc	<i>GPCC data downloader</i>
---------------	-----------------------------

Description

Function for downloading GPCC NC file.

Usage

```
download_gpcc(folder_path, resolution = 0.5)
```

Arguments

folder_path a character string with the path where the "raw" folder is located.

resolution numeric. Data spatial resolution. Suitable options are:

- 0.5 for 0.5 degree,
- 1 for 1 degree,
- 2.5 for 2.5 degree.

Value

No return value, called to download the data set.

download_gpcp	<i>GPCP data downloader</i>
---------------	-----------------------------

Description

Function for downloading GPCP NC file.

Usage

```
download_gpcp(folder_path)
```

Arguments

folder_path a character string with the path where the "raw" folder is located.

Value

No return value, called to download the data set.

download_gpm_imergm	<i>GPM data downloader</i>
---------------------	----------------------------

Description

Function for downloading GPM HDF5 files.

Usage

```
download_gpm_imergm(folder_path, start_year = 2000, end_year = 2020)
```

Arguments

folder_path a character string with the path where the "raw" folder is located.
start_year numeric. Start year should be between 2000-2020.
end_year numeric. End year should be between 2000-2020, and should be greater or equal to start year.

Value

No return value, called to download the data set.

Note

user must [Create an Earthdata account](#) and [Link GES DISC](#)

download_ncep_doe *NCEP/DOE data downloader*

Description

Function for downloading NCEP/DOE NC files.

Usage

download_ncep_doe(folder_path)

Arguments

folder_path a character string with the path where the "raw" folder is located.

Value

No return value, called to download the data set.

download_ncep_ncar *NCEP/NCAR data downloader*

Description

Function for downloading NCEP/NCAR NC files.

Usage

download_ncep_ncar(folder_path)

Arguments

folder_path a character string with the path where the "raw" folder is located.

Value

No return value, called to download the data set.

download_precl	<i>PRECL data downloader</i>
----------------	------------------------------

Description

Function for downloading PRECL NC file.

Usage

```
download_precl(folder_path, resolution = 0.5)
```

Arguments

folder_path	a character string with the path where the "raw" folder is located.
resolution	numeric. Data spatial resolution. Suitable options are: <ul style="list-style-type: none">• 0.5 for 0.5 degree,• 1 for 1 degree,• 2.5 for 2.5 degree.

Value

No return value, called to download the data set.

download_trmm_3b43	<i>TRMM data downloader</i>
--------------------	-----------------------------

Description

Function for downloading TRMM 3B43 HDF files.

Usage

```
download_trmm_3b43(folder_path, start_year = 1998, end_year = 2019)
```

Arguments

folder_path	a character string with the path where the "raw" folder is located.
start_year	numeric. Start year should be between 1998-2019.
end_year	numeric. End year should be between 1979-2019, and should be greater or equal to start year.

Value

No return value, called to download the data set.

Note

user must [Create an Earthdata account](#) and [Link GES DISC](#)

download_udel	<i>UDEL data downloader</i>
---------------	-----------------------------

Description

Function for downloading UDEL NC file.

Usage

```
download_udel(folder_path)
```

Arguments

folder_path a character string with the path where the "raw" folder is located.

Value

No return value, called to download the data set.

dt_aggregate	<i>Data table aggregation in space</i>
--------------	--

Description

Function for upscaling spatial resolution on pRecipe data tables

Usage

```
dt_aggregate(data, resolution)
```

Arguments

data data.table. A precipitation data table reformatted by pRecipe.
 resolution numeric. The upscale target resolution.

Value

the aggregated data table at the new spatial resolution.

dt_parallel	<i>Data table weighted mean for parallel computing</i>
-------------	--

Description

Function for merging data sets available in pRecipe data table by weighted mean.

Usage

```
dt_parallel(dummie_table)
```

Arguments

dummie_table A pRecipe data table with multiple data sets.

Value

a data table with the weighted average of the original.

import_full_data	<i>Read precipitation data.table from database</i>
------------------	--

Description

The function `import_full_data` imports the requested data sets.

Usage

```
import_full_data(name, database_folder_path = "./data/database")
```

Arguments

name a character string with the name of the desired data set. Suitable options are:

- "all" for all of the below listed data sets,
- "20cr" for 20CR v3,
- "cmap" for CMAP standard version,
- "cpc" for CPC-Global,
- "cru_ts" for CRU_TS v4.05,
- "ghcn" for GHCN-M v2
- "gpcc" for GPCC v2018,
- "gpcp" for GPCP v2.3,
- "gpm_imergm" for GPM IMERG Final v06,
- "ncep" for NCEP/NCAR,
- "ncep_doe" for NCEP/DOE,

- "precl" for PRECL,
- "trmm_3b43" for TRMM 3B43 v7,
- "udel" for UDEL v501.

database_folder_path

a character string with the path where the "database" folder is located.

Value

a data.table with the requested precipitation data sets.

Examples

```
## Not run:
x <- import_full_data("all", tempdir())
x <- import_full_data(c("cru_ts", "cpc", "ghcn", "gpcp"), tempdir())
x <- import_full_data(c("gpm_imergm", "trmm_3b43"), tempdir())

## End(Not run)
```

import_subset_data *Read and subset precipitation data sets*

Description

The function import_subset_data reads and subsets the requested data sets.

Usage

```
import_subset_data(
  name,
  start_year,
  end_year,
  bbox,
  database_folder_path = "./data/database"
)
```

Arguments

name a character string with the name of the desired data set. Suitable options are:

- "all" for all of the below listed data sets,
- "20cr" for 20CR v3,
- "cmap" for CMAP standard version,
- "cpc" for CPC-Global,
- "cru_ts" for CRU_TS v4.05,
- "ghcn" for GHCN-M v2
- "gpcp" for GPCC v2018,

- "gpcp" for GPCP v2.3,
- "gpm_imergm" for GPM IMERGM Final v06,
- "ncep" for NCEP/NCAR,
- "ncep_doe" for NCEP/DOE,
- "precl" for PRECL,
- "trmm_3b43" for TRMM 3B43 v7,
- "udel" for UDEL v501.

start_year numeric.
end_year numeric.
bbox numeric vector. Bounding box in the form: (xmin, ymin, xmax, ymax).
database_folder_path
 a character string with the path where the "database" folder is located.

Value

a data.table with the requested data sets subset

Examples

```
## Not run:
x <- import_subset_data(c("cru_ts", "cpc", "ghcn", "gpcp"), 2000, 2009,
c(12.24, 48.56, 18.85, 51.12), tempdir())

## End(Not run)
```

merge_1836_1890 *Data integrator for 1836_1890*

Description

Function for merging the data sets overlapping by time periods.

Usage

```
merge_1836_1890(folder_path)
```

Arguments

folder_path a character string with the path to the "database" folder.

Value

No return value, called for side effects.

merge_1891_2020	<i>Data integrator for 1891_2020.</i>
-----------------	---------------------------------------

Description

Function for merging the data sets overlapping by time periods.

Usage

```
merge_1891_2020(folder_path)
```

Arguments

folder_path a character string with the path to the "database" folder.

Value

No return value, called for side effects.

merge_time	<i>Data integrator.</i>
------------	-------------------------

Description

Function for merging the available data sets of a given year by weighted average.

Usage

```
merge_time(database_folder_path = "../data/database")
```

Arguments

database_folder_path
 a character string with the path to the "database" folder.

Value

No return value, called to merge all available data sets into one.

plot_bar	<i>Precipitation bar plot</i>
----------	-------------------------------

Description

Function for plotting (bar plot) monthly area averaged precipitation.

Usage

plot_bar(x)

Arguments

x a pRecipe data.table.

Value

ggplot object

plot_box	<i>Precipitation box plot</i>
----------	-------------------------------

Description

Function for plotting (box plot) monthly area averaged precipitation.

Usage

plot_box(x)

Arguments

x a pRecipe data.table.

Value

ggplot object

plot_line	<i>Precipitation line plot</i>
-----------	--------------------------------

Description

Function for plotting monthly time-series of area averaged precipitation.

Usage

```
plot_line(x)
```

Arguments

x a pRecipe data.table.

Value

ggplot object

plot_map	<i>Precipitation map</i>
----------	--------------------------

Description

Function for plotting precipitation maps.

Usage

```
plot_map(x, monthly = FALSE)
```

Arguments

x a pRecipe data.table.
monthly logical. If TRUE will generate one plot per month.

Value

list with ggplot objects

plot_matrix	<i>Precipitation matrix</i>
-------------	-----------------------------

Description

Function for plotting monthly precipitation matrices.

Usage

```
plot_matrix(x)
```

Arguments

x a pRecipe data.table.

Value

list with ggplot objects

reformat_20cr	<i>20CR data reformatter</i>
---------------	------------------------------

Description

Function for reading 20CR NC files, and reformatting them into data.table which is stored in an .Rds file.

Usage

```
reformat_20cr(folder_path)
```

Arguments

folder_path a character string with the path to the "raw" folder.

Value

No return value, called to reformat the downloaded data set into pRecipe object.

reformat_all	<i>All data reformatter</i>
--------------	-----------------------------

Description

Function for reformatting all of the available data sets.

Usage

```
reformat_all(folder_path)
```

Arguments

folder_path a character string with the path to the "raw" folder.

Value

No return value, called to reformat the downloaded data sets into pRecipe objects.

reformat_cmap	<i>CMAP data reformatter</i>
---------------	------------------------------

Description

Function for reading CMAP NC files, and reformatting them into data.table which is stored in an .Rds file.

Usage

```
reformat_cmap(folder_path)
```

Arguments

folder_path a character string with the path to the "raw" folder.

Value

No return value, called to reformat the downloaded data set into pRecipe object.

reformat_cpc	<i>CPC data reformatter</i>
--------------	-----------------------------

Description

Function for reading CPC-GLOBAL NC files, and reformatting them into `data.table` which is stored in an `.Rds` file.

Usage

```
reformat_cpc(folder_path)
```

Arguments

`folder_path` a character string with the path to the "raw" folder.

Value

No return value, called to reformat the downloaded data set into `pRecipe` object.

reformat_cru_ts	<i>CRU data reformatter</i>
-----------------	-----------------------------

Description

Function for reading CRU_TS NC.GZ file, and reformatting them into `data.table` which is stored in an `.Rds` file.

Usage

```
reformat_cru_ts(folder_path)
```

Arguments

`folder_path` a character string with the path to the "raw" folder.

Value

No return value, called to reformat the downloaded data set into `pRecipe` object.

reformat_data	<i>Reformat the downloaded data sets into .Rds files</i>
---------------	--

Description

The function `reformat_data` reformats the data sets into monthly total precipitation data.tables at 0.5 degree resolution.

Usage

```
reformat_data(raw_folder_path = "./data/raw", name = "all")
```

Arguments

<code>raw_folder_path</code>	a character string with the path where the "raw" folder is located.
<code>name</code>	a character string with the name of the desired data set. Suitable options are: <ul style="list-style-type: none">• "all" for all of the below listed data sets (default),• "20cr" for 20CR v3,• "cmap" for CMAP standard version,• "cpc" for CPC-Global,• "cru_ts" for CRU_TS v4.05,• "ghcn" for GHCN-M v2• "gpcc" for GPCC v2018,• "gpcp" for GPCP v2.3,• "gpm_imergm" for GPM IMERG Final v06,• "ncep" for NCEP/NCAR,• "ncep_doe" for NCEP/DOE,• "precl" for PRECL,• "trmm_3b43" for TRMM 3B43 v7,• "udel" for UDEL v501.

Value

No return value, called to reformat the downloaded data sets into pRecipe objects.

Examples

```
## Not run:  
reformat_data(tempdir())  
reformat_data(tempdir(), c("gpm_imergm", "trmm_3b43"))  
  
## End(Not run)
```

reformat_ghcn	<i>GHCN-M data reformatter</i>
---------------	--------------------------------

Description

Function for reading GHCN-M NC file, and reformatting them into data.table which is stored in an .Rds file.

Usage

```
reformat_ghcn(folder_path)
```

Arguments

folder_path a character string with the path to the "raw" folder.

Value

No return value, called to reformat the downloaded data set into pRecipe object.

reformat_gpcc	<i>GPCC data reformatter</i>
---------------	------------------------------

Description

Function for reading GPCC NC file, and reformatting them into data.table which is stored in an .Rds file.

Usage

```
reformat_gpcc(folder_path)
```

Arguments

folder_path a character string with the path to the "raw" folder.

Value

No return value, called to reformat the downloaded data set into pRecipe object.

reformat_gpcp	<i>GPCP data reformatter</i>
---------------	------------------------------

Description

Function for reading GPCP NC file, and reformatting them into data.table which is stored in an .Rds file.

Usage

```
reformat_gpcp(folder_path)
```

Arguments

folder_path a character string with the path to the "raw" folder.

Value

No return value, called to reformat the downloaded data set into pRecipe object.

reformat_gpm_imergm	<i>GPM data reformatter</i>
---------------------	-----------------------------

Description

Function for reading GPM HDF5 files, and reformatting them into data.table which is stored in an .Rds file.

Usage

```
reformat_gpm_imergm(folder_path)
```

Arguments

folder_path a character string with the path to the "raw" folder.

Value

No return value, called to reformat the downloaded data set into pRecipe object.

reformat_ncep_doe	<i>NCEP/DOE data reformatter</i>
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Description

Function for reading NCEP/DOE NC files, and reformatting them into `data.table` which is stored in an `.Rds` file.

Usage

```
reformat_ncep_doe(folder_path)
```

Arguments

`folder_path` a character string with the path to the "raw" folder.

Value

No return value, called to reformat the downloaded data set into `pRecipe` object.

reformat_ncep_ncar	<i>NCEP/NCAR data reformatter</i>
--------------------	-----------------------------------

Description

Function for reading NCEP/NCAR NC files, and reformatting them into `data.table` which is stored in an `.Rds` file.

Usage

```
reformat_ncep_ncar(folder_path)
```

Arguments

`folder_path` a character string with the path to the "raw" folder.

Value

No return value, called to reformat the downloaded data set into `pRecipe` object.

reformat_precl	<i>PRECL data reformatter</i>
----------------	-------------------------------

Description

Function for reading PRECL NC file, and reformatting them into data.table which is stored in an .Rds file.

Usage

```
reformat_precl(folder_path)
```

Arguments

folder_path a character string with the path to the "raw" folder.

Value

No return value, called to reformat the downloaded data set into pRecipe object.

reformat_trmm_3b43	<i>TRMM data reformatter</i>
--------------------	------------------------------

Description

Function for reading TRMM 3B43 HDF files, and reformatting them into data.table which is stored in an .Rds file.

Usage

```
reformat_trmm_3b43(folder_path)
```

Arguments

folder_path a character string with the path to the "raw" folder.

Value

No return value, called to reformat the downloaded data set into pRecipe object.

reformat_udel	<i>UDEL data reformatter</i>
---------------	------------------------------

Description

Function for reading UDEL NC file, and reformatting them into data.table which is stored in an .Rds file.

Usage

```
reformat_udel(folder_path)
```

Arguments

folder_path a character string with the path to the "raw" folder.

Value

No return value, called to reformat the downloaded data set into pRecipe object.

resample_data	<i>Resampling precipitation data sets</i>
---------------	---

Description

The function resample_data resamples the imported data.

Usage

```
resample_data(x, yearly = TRUE, resolution)
```

Arguments

x a pRecipe data.table imported using [import_full_data](#) or [import_subset_data](#).
yearly logical. If TRUE (default) monthly data will be aggregated into yearly.
resolution numeric. Desired spatial resolution (original is 0.5)

Value

a data.table with the resampled data sets

Examples

```
## Not run:  
x <- import_full_data(c("cru_ts", "cpc", "ghcn", "gpcp"), tempdir())  
y <- resample_data(x, yearly = FALSE, 5)  
z <- resample_data(x, yearly = TRUE, 2.5)  
  
## End(Not run)
```

sd_20cr

Download and reformat ensemble spread of 20CR v3 for 1836-1890

Description

Function for downloading and reformatting 20cr sd values between 1836 and 1890.

Usage

```
sd_20cr(destination)
```

Arguments

`destination` a character string with the path to the "integration/aux" folder.

Value

No return value, called for side effects.

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