

Package ‘pRecipe’

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Title Precipitation R Recipes

Version 3.0.1-3

Description An open-access tool/framework to download, validate, visualize, and analyze multi-source precipitation data. More information and an example of implementation can be found in Vargas Godoy and Markonis (2023, <[doi:10.1016/j.envsoft.2023.105711](https://doi.org/10.1016/j.envsoft.2023.105711)>).

Depends R (>= 4.0.0)

Imports grDevices, methods, parallel, stats, utils, data.table, doParallel, foreach, ggplot2, ggpubr, lubridate, magrittr, ncd4, openair, raster, scales, sf, sp

License GPL-3

Encoding UTF-8

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

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

SystemRequirements PROJ (>= 6, <https://proj.org/download.html>), GDAL (>= 3, <https://gdal.org/download.html>), NetCDF (>= 4, <https://www.unidata.ucar.edu/software/netcdf/>).

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R topics documented:

crop_data	2
csi	3
download_data	4
download_e_obs	5
far	6
fldmean	6
infoNC	7
label	8
muldpm	9
nse	10
plot_box	11
plot_density	12
plot_heatmap	13
plot_line	14
plot_map	15
plot_summary	15
plot_taylor	16
pod	17
pRecipe_masks	18
remap	18
saveNC	19
subset_data	20
tabular	21
trend	22
yearstat	22
Index	24

crop_data	<i>Crop precipitation data sets</i>
-----------	-------------------------------------

Description

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

Usage

```
crop_data(x, y)

## S4 method for signature 'Raster'
crop_data(x, y)

## S4 method for signature 'data.table'
crop_data(x, y)

## S4 method for signature 'character'
crop_data(x, y)
```

Arguments

x Raster* object; data.table (see details); filename (character; see details)
 y filename (character). Path to a *.shp file

Details

If 'x' is a data.table, its columns should be named: "lon", "lat", "date", and "value"

If 'x' is a filename, it should point to a *.nc file.

Value

Raster* object; data.table

Examples

```
## Not run:
download_data("gldas-vic", tempdir(), timestep = "yearly")
r <- raster::brick(paste0(tempdir(),
"/gldas-vic_tp_mm_land_194801_201412_025_yearly.nc"))
s <- crop_data(r, "cze.shp")

## End(Not run)
```

csi	<i>Probability of Detection</i>
-----	---------------------------------

Description

Function for calculating the critical success index.

Usage

```
csi(x, ref, th)
```

Arguments

x a data.table generated by [fldmean](#)
 ref a data.table with data used for evaluation
 th numeric. The value for detection threshold

Value

numeric

download_data	<i>Download various precipitation data products</i>
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Description

The function `download_data` downloads the selected data product.

Usage

```
download_data(  
  dataset = "all",  
  path = ".",  
  domain = "raw",  
  timestep = "monthly"  
)
```

Arguments

`dataset` a character string with the name(s) of the desired data set. Suitable options are:

- "all" for all of the below listed data sets (default),
- "20cr" for 20CR v3,
- "chirps" for CHIRPS v2.0,
- "cmap" for CMAP standard version,
- "cmorph" for CMORPH,
- "cpc" for CPC-Global,
- "cru-ts" for CRU_TS v4.06,
- "em-earth" for EM-EARTH,
- "era20c" for ERA-20C,
- "era5" for ERA5,
- "fldas" for FLDAS,
- "ghcn" for GHCN-M v2,
- "gldas-clsm" for GLDAS CLSM,
- "gldas-noah" for GLDAS NOAH,
- "gldas-vic" for GLDAS VIC,
- "gpcc" for GPCC v2020,
- "gpcp" for GPCP v2.3,
- "gpm_imer" for GPM IMERG Final v06,
- "jra55" for JRA-55,
- "merra2" for MERRA-2,
- "mswep" for MSWEP v2.8,
- "ncep-doe" for NCEP/DOE,
- "ncep-ncar" for NCEP/NCAR,
- "persiann" for PERSIANN-CDR,

	<ul style="list-style-type: none"> • "precl" for PREC/L, • "terraclimate" for TerraClimate, • "trmm-3b43" for TRMM 3B43 v7, • "udel" for UDEL v501.
path	a character string with the path where the database will be downloaded.
domain	a character string with the desired domain data set. Suitable options are: <ul style="list-style-type: none"> • "raw" for default available spatial coverage, • "global" for data sets with global (land and ocean) coverage, • "land" for data sets with land only coverage, • "ocean", for data sets with ocean only coverage.
timestep	a character string with the desired time resolution. Suitable options are: <ul style="list-style-type: none"> • "monthly", • "yearly".

Value

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

Examples

```
download_data("gldas-vic", tempdir(), timestep = "yearly")
```

download_e_obs	<i>E-OBS data downloader</i>
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Description

Function for downloading E-OBS.

Usage

```
download_e_obs(folder_path = ".", time_res = "monthly")
```

Arguments

folder_path	a character string with the path where the data will be downloaded.
time_res	a character string with the desired time resolution. Suitable options are: <ul style="list-style-type: none"> • "monthly", • "yearly".

Value

No return value, called to download the data set.

far	<i>False Alarm Rate</i>
-----	-------------------------

Description

Function for calculating the false alarm rate.

Usage

```
far(x, ref, th)
```

Arguments

x	a data.table generated by fldmean
ref	a data.table with data used for evaluation
th	numeric. The value for detection threshold

Value

numeric

fldmean	<i>Field mean</i>
---------	-------------------

Description

The function fldmean computes the spatial weighted average for each timestep.

Usage

```
fldmean(x)

## S4 method for signature 'Raster'
fldmean(x)

## S4 method for signature 'data.table'
fldmean(x)

## S4 method for signature 'character'
fldmean(x)
```

Arguments

x	Raster* object; data.table (see details); filename (character, see details)
---	-----------------------------------------------------------------------------

Details

If 'x' is a data.table, its columns should be named: "lon", "lat", "date", and "value"

If 'x' is a filename, it should point to a *.nc file.

Value

data.table

Examples

```
## Not run:
download_data("gldas-vic", tempdir(), timestep = "yearly")
r <- raster::brick(paste0(tempdir(),
"/gldas-vic_tp_mm_land_194801_201412_025_yearly.nc"))
s <- fldmean(r)

## End(Not run)
```

infoNC

Show data content

Description

The function infoNC displays the specification of the desired file.

Usage

```
infoNC(x)

## S4 method for signature 'Raster'
infoNC(x)

## S4 method for signature 'character'
infoNC(x)
```

Arguments

x Raster* Object; character

label

Labeling

Description

The function `label` adds data set name and source type.

Usage

```
label(x, y)
```

Arguments

<code>x</code>	data.table (see details)
<code>y</code>	character (see details)

Details

columns in `'x'` should be named (if present): "lon", "lat", "date", and "value"

Available options are:

- "20cr" for 20CR v3,
- "chirps" for CHIRPS v2.0,
- "cmap" for CMAP standard version,
- "cmorph" for CMORPH,
- "cpc" for CPC-Global,
- "cru-ts" for CRU_TS v4.06,
- "em-earth" for EM-EARTH,
- "era20c" for ERA-20C,
- "era5" for ERA5,
- "fldas" for FLDAS,
- "ghcn" for GHCN-M v2,
- "gldas-clsm" for GLDAS CLSM,
- "gldas-noah" for GLDAS NOAH,
- "gldas-vic" for GLDAS VIC,
- "gleam" for GLEAM v3.7a,
- "gpcc" for GPCC v2020,
- "gpcp" for GPCP v2.3,
- "gpm_imerg" for GPM IMERG Final v06,
- "jra55" for JRA-55,
- "merra2" for MERRA-2,

- "mswep" for MSWEP v2.8,
- "ncep-doe" for NCEP/DOE,
- "ncep-ncar" for NCEP/NCAR,
- "persiann" for PERSIANN-CDR,
- "precl" for PREC/L,
- "terraclimate" for TerraClimate,
- "trmm-3b43" for TRMM 3B43 v7,
- "udel" for UDEL v501.

Value

data.table

Examples

```
## Not run:
r <- data.table::data.table("date" = as.Date("2000-01-01"), "value" = 42)
s <- label(r, "mswep")

## End(Not run)
```

muldpm	<i>Multiply by days per month</i>
--------	-----------------------------------

Description

The function muldpm multiplies the value by days per month.

Usage

```
muldpm(x)

## S4 method for signature 'Raster'
muldpm(x)

## S4 method for signature 'data.table'
muldpm(x)

## S4 method for signature 'character'
muldpm(x)
```

Arguments

x Raster* object; data.table (see details); filename (character, see details)

Details

'x' object with monthly data in [units/day]

If 'x' is a data.table, its columns should be named: "lon", "lat", "date", and "value"

If 'x' is a filename, it should point to a *.nc file.

Value

Raster* object; data.table

Examples

```
## Not run:
tavg_brick <- raster::brick('terraclimate_tavg.nc')
pet_od <- pet(method = "od", tavg = tavg_brick)
pet_od <- muldpm(pet_od)

## End(Not run)
```

nse

Nash–Sutcliffe Efficiency

Description

Function for calculating the Nash–Sutcliffe efficiency.

Usage

```
nse(x, ref)
```

Arguments

x	a data.table generated by fldmean
ref	a data.table with data used for evaluation

Value

numeric

plot_box	<i>Boxplot ggplot</i>
----------	-----------------------

Description

Convenient and aesthetic visualization of data in a boxplot.

Usage

```
plot_box(x, var = "Precipitation", unit = "mm")

## S4 method for signature 'Raster'
plot_box(x, var = "Precipitation", unit = "mm")

## S4 method for signature 'data.table'
plot_box(x, var = "Precipitation", unit = "mm")

## S4 method for signature 'character'
plot_box(x, var = "Precipitation", unit = "mm")
```

Arguments

x	Raster* object; data.table (see details); filename (character, see details)
var	character (see details)
unit	character (see details)

Details

If ‘x’ is a data.table, its columns should be named: "lon", "lat", "date", and "value"

If ‘x’ is a filename, it should point to a *.nc file.

‘var’ is a character string describing the variable to be used for the plot title

‘unit’ is a character string describing the unit of measurement to be used for the plot title

Value

ggplot object

Examples

```
## Not run:
download_data("gldas-vic", tempdir(), timestep = "yearly")
r <- raster::brick(paste0(tempdir(),
"/gldas-vic_tp_mm_land_194801_201412_025_yearly.nc"))
s <- plot_box(r)

## End(Not run)
```

plot_density	<i>Histogram ggplot</i>
--------------	-------------------------

Description

Convenient and aesthetic visualization of data in a histogram.

Usage

```
plot_density(x, var = "Precipitation", unit = "mm")

## S4 method for signature 'Raster'
plot_density(x, var = "Precipitation", unit = "mm")

## S4 method for signature 'data.table'
plot_density(x, var = "Precipitation", unit = "mm")

## S4 method for signature 'character'
plot_density(x, var = "Precipitation", unit = "mm")
```

Arguments

x	Raster* object; data.table (see details); filename (character, see details)
var	character (see details)
unit	character (see details)

Details

If ‘x’ is a data.table, its columns should be named: "lon", "lat", "date", and "value"

If ‘x’ is a filename, it should point to a *.nc file.

‘var’ is a character string describing the variable to be used for the axis title

‘unit’ is a character string describing the unit of measurement to be used for the axis title

Value

ggplot object

Examples

```
## Not run:
download_data("gldas-vic", tempdir(), timestep = "yearly")
r <- raster::brick(paste0(tempdir(),
"/gldas-vic_tp_mm_land_194801_201412_025_yearly.nc"))
s <- plot_density(r)

## End(Not run)
```

plot_heatmap	<i>Heatmap ggplot</i>
--------------	-----------------------

Description

Convenient and aesthetic visualization of data in a heatmap.

Usage

```
plot_heatmap(x, unit = "mm")

## S4 method for signature 'Raster'
plot_heatmap(x, unit = "mm")

## S4 method for signature 'data.table'
plot_heatmap(x, unit = "mm")

## S4 method for signature 'character'
plot_heatmap(x, unit = "mm")
```

Arguments

x	Raster* object; data.table (see details); filename (character, see details)
unit	character (see details)

Details

If ‘x’ is a data.table, its columns should be named: "lon", "lat", "date", and "value"

If ‘x’ is a filename, it should point to a *.nc file.

‘unit’ is a character string describing the unit of measurement to be used for the axis title

Value

ggplot object

Examples

```
## Not run:
download_data("gldas-vic", tempdir(), timestep = "yearly")
r <- raster::brick(paste0(tempdir(),
"/gldas-vic_tp_mm_land_194801_201412_025_yearly.nc"))
s <- plot_heatmap(r)

## End(Not run)
```

plot_line

Line ggplot

Description

Convenient and aesthetic visualization of data in a line plot.

Usage

```
plot_line(x, var = "Precipitation", unit = "mm")

## S4 method for signature 'Raster'
plot_line(x, var = "Precipitation", unit = "mm")

## S4 method for signature 'data.table'
plot_line(x, var = "Precipitation", unit = "mm")

## S4 method for signature 'character'
plot_line(x, var = "Precipitation", unit = "mm")
```

Arguments

x	Raster* object; data.table (see details); filename (character, see details)
var	character (see details)
unit	character (see details)

Details

If ‘x’ is a data.table, its columns should be named: "lon", "lat", "date", and "value"

If ‘x’ is a filename, it should point to a *.nc file.

‘var’ is a character string describing the variable to be used for the axis title

‘unit’ is a character string describing the unit of measurement to be used for the axis title

Value

ggplot object

Examples

```
## Not run:
download_data("gldas-vic", tempdir(), timestep = "yearly")
r <- raster::brick(paste0(tempdir(),
"/gldas-vic_tp_mm_land_194801_201412_025_yearly.nc"))
s <- plot_line(r)

## End(Not run)
```

`plot_map`*Map ggplot*

Description

Convenient and aesthetic visualization of data in a map

Usage

```
plot_map(x, unit = "mm")

## S4 method for signature 'Raster'
plot_map(x, unit = "mm")

## S4 method for signature 'data.table'
plot_map(x, unit = "mm")

## S4 method for signature 'character'
plot_map(x, unit = "mm")
```

Arguments

<code>x</code>	Raster* object; data.table (see details); filename (character, see details)
<code>unit</code>	character

Details

If ‘x’ is a data.table, its columns should be named: "lon", "lat", "date", and "value"

If ‘x’ is a filename, it should point to a *.nc file.

‘unit’ is a character string describing the unit of measurement to be used for the legend title

Value

ggplot object

`plot_summary`*Summary ggplot*

Description

Convenient and aesthetic visualization of data in a summary plot.

Usage

```
plot_summary(x, var = "Precipitation", unit = "mm")

## S4 method for signature 'Raster'
plot_summary(x, var = "Precipitation", unit = "mm")

## S4 method for signature 'data.table'
plot_summary(x, var = "Precipitation", unit = "mm")

## S4 method for signature 'character'
plot_summary(x, var = "Precipitation", unit = "mm")
```

Arguments

x	Raster* object; data.table (see details); filename (character, see details)
var	character (see details)
unit	character (see details)

Details

If ‘x’ is a data.table, its columns should be named: "lon", "lat", "date", and "value"

If ‘x’ is a filename, it should point to a *.nc file.

‘var’ is a character string describing the variable to be used for the axis title

‘unit’ is a character string describing the unit of measurement to be used for the axis title

Value

ggplot object

Examples

```
## Not run:
download_data("gldas-vic", tempdir(), timestep = "yearly")
r <- raster::brick(paste0(tempdir(),
"/gldas-vic_tp_mm_land_194801_201412_025_yearly.nc"))
s <- plot_summary(r)

## End(Not run)
```

plot_taylor

Taylor diagram

Description

Convenient and aesthetic visualization of data in a Taylor diagram.

Usage

```
plot_taylor(x, y, groups = "source", ...)
```

Arguments

x	data.table
y	data.table
groups	character
...	see details

Details

‘x’ columns should be named: "lon", "lat", "date", "value", "dataset", and "source". The last two columns are added using the [label](#).

‘y’ columns should be named: "lon", "lat", "date", "value", "dataset", and "source". The last two columns are added using the [label](#).

‘groups’ character to define panels. Suitable options are:

- "source" (default)
- "seasons" (only works properly with monthly data)

‘...’ extra arguments passed on to `openair::TaylorDiagram`

Value

plot object

pod	<i>Probability Of Detection</i>
-----	---------------------------------

Description

Function for calculating the probability of detection.

Usage

```
pod(x, ref, th)
```

Arguments

x	a data.table generated by fldmean
ref	a data.table with data used for evaluation
th	numeric. The value for detection threshold

Value

numeric

pRecipe_masks	<i>Masks data</i>
---------------	-------------------

Description

Function for various masks.

Usage

```
pRecipe_masks()
```

Value

data.table

remap	<i>Spatial aggregation</i>
-------	----------------------------

Description

The function remap aggregates data into a new grid resolution.

Usage

```
remap(x, y)

## S4 method for signature 'Raster'
remap(x, y)

## S4 method for signature 'data.table'
remap(x, y)

## S4 method for signature 'character'
remap(x, y)
```

Arguments

x	Raster* object; data.table (see details); filename (character, see details)
y	numeric

Details

If 'x' is a data.table, its columns should be named: "lon", "lat", "date", and "value"

If 'x' is a filename, it should point to a *.nc file.

Value

Raster* object; data.table

Examples

```
## Not run:
download_data("gldas-vic", tempdir(), timestep = "yearly")
r <- raster::brick(paste0(tempdir(),
"/gldas-vic_tp_mm_land_194801_201412_025_yearly.nc"))
s <- remap(r, 1)

## End(Not run)
```

saveNC

Save .nc file

Description

Function to save data compatible with pRecipe in .nc file

Usage

```
saveNC(x, file, name = "tp", longname = "Total precipitation", units = "mm")
```

Arguments

x	Raster* object
file	character
name	character
longname	character
units	character

Value

No return value, called to save a file

Examples

```
## Not run:
save_nc(dummie_brick, "gpcp_tp_mm_global_197901_202205_025_monthly.nc")

## End(Not run)
```

subset_data

*Subset data in space and time***Description**

The function `subset_data` subsets the data in space within a bounding box, and/or in time within a year range.

Usage

```
subset_data(x, box = NULL, yrs = NULL)
```

```
## S4 method for signature 'Raster'
subset_data(x, box = NULL, yrs = NULL)
```

```
## S4 method for signature 'data.table'
subset_data(x, box = NULL, yrs = NULL)
```

```
## S4 method for signature 'character'
subset_data(x, box = NULL, yrs = NULL)
```

Arguments

<code>x</code>	Raster* object; data.table (see details); filename (character, see details)
<code>box</code>	numeric. Bounding box in the form: (xmin, xmax, ymin, ymax)
<code>yrs</code>	numeric. Time range in the form: (start_year, end_year)

Details

If ‘`x`’ is a `data.table`, its columns should be named: "lon", "lat", "date", and "value"

If ‘`x`’ is a filename, it should point to a *.nc file.

If subsetting only in space or time then the arguments must be passed by name. I.e., `subset_data(x, box = ...)` (space) or `subset_data(x, yrs = ...)` (time)

Value

Raster* object; data.table

Examples

```
## Not run:
download_data("gldas-vic", tempdir(), timestep = "yearly")
r <- raster::brick(paste0(tempdir(),
"/gldas-vic_tp_mm_land_194801_201412_025_yearly.nc"))
sd <- subset_data(r, c(12.24, 18.85, 48.56, 51.12), c(2000, 2010))
ss <- subset_data(r, box = c(12.24, 18.85, 48.56, 51.12))
st <- subset_data(r, yrs = c(2000, 2010))
```

```
## End(Not run)
```

tabular	<i>Transform raster into data.table</i>
---------	-----------------------------------------

Description

Function to transform a raster brick into a data.table

Usage

```
tabular(x)

## S4 method for signature 'Raster'
tabular(x)

## S4 method for signature 'character'
tabular(x)
```

Arguments

x Raster* object; filename (character, see details)

Value

data.table

Examples

```
## Not run:
download_data("gldas-vic", tempdir(), timestep = "yearly")
r <- raster::brick(paste0(tempdir(),
"/gldas-vic_tp_mm_land_194801_201412_025_yearly.nc"))
s <- tabular(r)

## End(Not run)
```

trend	<i>Trends</i>
-------	---------------

Description

The function `trend` computes linear slope.

Usage

```
trend(x)

## S4 method for signature 'Raster'
trend(x)

## S4 method for signature 'data.table'
trend(x)

## S4 method for signature 'character'
trend(x)
```

Arguments

`x` Raster* object; data.table (see details); filename (character, see details)

Details

If `'x'` is a data.table, its columns should be named: "lon", "lat", "date", and "value"

If `'x'` is a filename, it should point to a *.nc file.

Value

Raster* object; data.table

yearstat	<i>Yearly <stat></i>
----------	----------------------------

Description

The function `yearstat` aggregates the data from monthly to yearly.

Usage

```
yearstat(x, stat = "sum")

## S4 method for signature 'Raster'
yearstat(x, stat = "sum")

## S4 method for signature 'data.table'
yearstat(x, stat = "sum")

## S4 method for signature 'character'
yearstat(x, stat = "sum")
```

Arguments

x	Raster* object; data.table (see details); filename (character, see details)
stat	character

Details

If 'x' is a data.table, its columns should be named: "lon", "lat", "date", and "value"

If 'x' is a filename, it should point to a *.nc file.

'stat' is a character string describing the desired aggregation function. Suitable options are:

- "max"
- "mean"
- "median"
- "min"
- "sum" (default)

Value

Raster* object; data.table

Examples

```
## Not run:
download_data("gldas-vic", path = tempdir())
r <- raster::brick(paste0(tempdir(),
"/gldas-vic_tp_mm_land_194801_201412_025_monthly.nc"))
s <- yearstat(r, "mean")

## End(Not run)
```

Index

crop_data, 2
crop_data, character-method (crop_data), 2
crop_data, data.table-method (crop_data), 2
crop_data, Raster-method (crop_data), 2
csi, 3

download_data, 4
download_e_obs, 5

far, 6
fldmean, 3, 6, 6, 10, 17
fldmean, character-method (fldmean), 6
fldmean, data.table-method (fldmean), 6
fldmean, Raster-method (fldmean), 6

infoNC, 7
infoNC, character-method (infoNC), 7
infoNC, Raster-method (infoNC), 7

label, 8, 17

muldpm, 9
muldpm, character-method (muldpm), 9
muldpm, data.table-method (muldpm), 9
muldpm, Raster-method (muldpm), 9

nse, 10

plot_box, 11
plot_box, character-method (plot_box), 11
plot_box, data.table-method (plot_box), 11
plot_box, Raster-method (plot_box), 11
plot_density, 12
plot_density, character-method (plot_density), 12
plot_density, data.table-method (plot_density), 12

plot_density, Raster-method (plot_density), 12
plot_heatmap, 13
plot_heatmap, character-method (plot_heatmap), 13
plot_heatmap, data.table-method (plot_heatmap), 13
plot_heatmap, Raster-method (plot_heatmap), 13
plot_line, 14
plot_line, character-method (plot_line), 14
plot_line, data.table-method (plot_line), 14
plot_line, Raster-method (plot_line), 14
plot_map, 15
plot_map, character-method (plot_map), 15
plot_map, data.table-method (plot_map), 15
plot_map, Raster-method (plot_map), 15
plot_summary, 15
plot_summary, character-method (plot_summary), 15
plot_summary, data.table-method (plot_summary), 15
plot_summary, Raster-method (plot_summary), 15
plot_taylor, 16
pod, 17
pRecipe_masks, 18

remap, 18
remap, character-method (remap), 18
remap, data.table-method (remap), 18
remap, Raster-method (remap), 18

saveNC, 19
subset_data, 20
subset_data, character-method (subset_data), 20

subset_data, data.table-method
 (subset_data), [20](#)
subset_data, Raster-method
 (subset_data), [20](#)

tabular, [21](#)
tabular, character-method (tabular), [21](#)
tabular, Raster-method (tabular), [21](#)
TaylorDiagram, [17](#)
trend, [22](#)
trend, character-method (trend), [22](#)
trend, data.table-method (trend), [22](#)
trend, Raster-method (trend), [22](#)

yearstat, [22](#)
yearstat, character-method (yearstat), [22](#)
yearstat, data.table-method (yearstat),
 [22](#)
yearstat, Raster-method (yearstat), [22](#)