

Package ‘MESHr’

October 23, 2018

Type Package

Title pre- and post processing for MESH

Version 0.1.1

Date 2018-10-23

Author Al Pietroniro, Environment Canada

Maintainer Kevin Shook <kevin.shook@usask.ca>

Description This package contains functions for pre- and post- processing data for the MESH model.

Depends R (>= 3.1)

Imports grid, ggplot2, stringr, reshape2, knitr, hydroGOF, raster, rts, readr

License GPL-3

LazyData true

URL <https://github.com/CentreForHydrology/MESHr>

RoxygenNote 6.1.0

NeedsCompilation no

VignetteBuilder knitr

R topics documented:

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| | |
|---------------|---|
| MEShr-package | <i>Functions for MESH pre- and post- processing</i> |
|---------------|---|

Description

The intent of this package is to contain functions do do common tasks for MESH modelling, such as reading output, plotting, and assessing model quality. The first functions will use .csv files - support for netCDF will be added.

References

To cite **MEShr** in publications, use the command `citation("MEShr")` to get the current version of the citation.

| | |
|---------------------------|---|
| basinPrecipEvapRunoffPlot | <i>Plots basin precipitation evaporation and runoff</i> |
|---------------------------|---|

Description

Plots basin precipitation evaporation and runoff

Usage

`basinPrecipEvapRunoffPlot(basinWaterBalance)`

Arguments

basinWaterBalance
Required. Data frame to be plotted. As read in by read_MESH_OutputTimeseries_csv.

Value

Returns a **ggplot2** line plot of the variable values (mm).

Author(s)

Kevin Shook

See Also[read_MESH_OutputTimeseries_csv](#) [basinStoragePlot](#) [basinSoilWaterIcePlot](#)**Examples**

```
## Not run:
waterBalance <- read_MESH_OutputTimeseries_csv("Basin_average_water_balance.csv")
p <- basinPrecipEvapRunoffPlot(waterBalance)
## End(Not run)
```

| | |
|-----------------|--------------------------------------|
| basinRunoffPlot | <i>Plots basin runoff components</i> |
|-----------------|--------------------------------------|

Description

Plots basin runoff components

Usage

```
basinRunoffPlot(basinWaterBalance, cumul = FALSE)
```

Arguments

| | |
|-------------------|---|
| basinWaterBalance | Required. Data frame to be plotted. As read in by <code>read_MESH_OutputTimeseries_csv</code> . |
| cumul | Optional. If FALSE, then interval values are plotted. If TRUE (the default) then cumulative values are plotted. Note that the cumulative values are determined by summing the interval values <i>not</i> by plotting the MESH cumulative variables. |

ValueReturns a **ggplot2** line plot of the variable values (mm).**Author(s)**

Kevin Shook

See Also[read_MESH_OutputTimeseries_csv](#) [basinStoragePlot](#) [basinSoilWaterIcePlot](#)

Examples

```
## Not run:  
waterBalance <- read_MESH_OutputTimeseries_csv("Basin_average_water_balance.csv")  
p <- basinRunoffPlot(waterBalance)  
## End(Not run)
```

basinSnowPlot

Plots basin snow water equivalent

Description

Plots basin snow water equivalent

Usage

```
basinSnowPlot(basinWaterBalance)
```

Arguments

basinWaterBalance

Required. Data frame to be plotted. As read in by read_MESH_OutputTimeseries_csv.

Value

Returns a **ggplot2** stacked line plot of the basin SWE (mm).

Author(s)

Kevin Shook

See Also

[read_MESH_OutputTimeseries_csv](#) [basinStoragePlot](#)

Examples

```
## Not run:  
waterBalance <- read_MESH_OutputTimeseries_csv("Basin_average_water_balance.csv")  
p <- basinSnowPlot(waterBalance)  
## End(Not run)
```

`basinSnowRainPondedPlot`*Plots basin snow and rain in the canopy and ponded water*

Description

Plots basin snow and rain in the canopy and ponded water

Usage

```
basinSnowRainPondedPlot(basinWaterBalance)
```

Arguments

`basinWaterBalance`

Required. Data frame to be plotted. As read in by `read_MESH_OutputTimeseries_csv`.

Value

Returns a **ggplot2** line plot of the basin variables (mm).

Author(s)

Kevin Shook

See Also

[read_MESH_OutputTimeseries_csv](#) [basinStoragePlot](#)

Examples

```
## Not run:  
waterBalance <- read_MESH_OutputTimeseries_csv("Basin_average_water_balance.csv")  
p <- basinSnowRainPondedPlot(waterBalance)  
## End(Not run)
```

`basinSoilWaterIcePlot` *Plots basin soil water and ice*

Description

Plots basin soil water and ice

Usage

```
basinSoilWaterIcePlot(basinWaterBalance, layers = c(1, 2))
```

Arguments

| | |
|-------------------|---|
| basinWaterBalance | Required. Data frame to be plotted. As read in by read_MESH_OutputTimeseries_csv. |
| layers | Optional. A vector of the layers to be plotted. By default layers 1 and 2 are used. |

Value

Returns a **ggplot2** line plot of the variable values (mm) faceted by Layer number. The name of the variable is layer, so you can change change the facetting.

Author(s)

Kevin Shook

See Also

[read_MESH_OutputTimeseries_csv](#) [basinStoragePlot](#)

Examples

```
## Not run:
waterBalance <- read_MESH_OutputTimeseries_csv("Basin_average_water_balance.csv")
p <- basinSoilWaterIcePlot(waterBalance)
## End(Not run)
```

| | |
|--------------------|--------------------------------------|
| basinSoilWaterPlot | <i>Plots basin soil liquid water</i> |
|--------------------|--------------------------------------|

Description

Plots basin soil liquid water

Usage

```
basinSoilWaterPlot(basinWaterBalance, layers = c(1, 2, 3, 4, 5, 6))
```

Arguments

| | |
|-------------------|--|
| basinWaterBalance | Required. Data frame to be plotted. As read in by read_MESH_OutputTimeseries_csv. |
| layers | Optional. A vector of the layers to be plotted. By default layers 1 though 6 are used. |

Value

Returns a **ggplot2** line plot of the variable values (mm).

Author(s)

Kevin Shook

See Also[read_MESH_OutputTimeseries_csv](#) [basinStoragePlot](#) [basinSoilWaterIcePlot](#)**Examples**

```
## Not run:
waterBalance <- read_MESH_OutputTimeseries_csv("Basin_average_water_balance.csv")
p <- basinSoilWaterPlot(waterBalance)
## End(Not run)
```

| | |
|------------------|----------------------------------|
| basinStoragePlot | <i>Plots total basin storage</i> |
|------------------|----------------------------------|

Description

Plots total basin storage

Usage

```
basinStoragePlot(basinWaterBalance)
```

Arguments

basinWaterBalance

Required. Data frame to be plotted. As read in by [read_MESH_OutputTimeseries_csv](#).**Value**Returns a **ggplot2** line plot of the value of STG (mm).**Author(s)**

Kevin Shook

See Also[read_MESH_OutputTimeseries_csv](#) [basinStorageVariablesPlot](#) [basinSoilWaterIcePlot](#)**Examples**

```
## Not run:
waterBalance <- read_MESH_OutputTimeseries_csv("Basin_average_water_balance.csv")
p <- basinStoragePlot(waterBalance)
## End(Not run)
```

basinStorageVariablesPlot

Plots basin water balance storage components

Description

Creates a **ggplot2** stacked area plot of specified water balance storage components. The variables plotted may include:

variable definition

SNCAN Snow component of precipitation intercepted by the canopy

RCAN Rain component of precipitation intercepted by the canopy mm or kg m⁻² of water AVG

SNO Snow water equivalent (SWE) of the snow mass

ZPND Depth of water ponded at the surface

LQWS Water equivalent of the volumetric liquid water content of the soil

FZWS Water equivalent of the volumetric frozen water content of the soil

ALWS Water equivalent of the volumetric liquid and frozen water contents of the soil, sum of LQWS and FZWS

Usage

```
basinStorageVariablesPlot(basinWaterBalance, varNames = "",
  layers = c(1, 2, 3, 4, 5, 6))
```

Arguments

| | |
|-------------------|--|
| basinWaterBalance | Required. Data frame to be plotted. As read in by read_MESH_OutputTimeseries_csv. |
| varNames | Optional. A vector of the names of the variables to be plotted. If not specified, all of the variables listed above will be plotted. |
| layers | Optional. A vector of the layers to be plotted. By default layers 1 through 6 are used. |

Value

Returns a **ggplot2** stacked area time plot of the variable values (mm).

Author(s)

Kevin Shook

See Also

[read_MESH_OutputTimeseries_csv](#)

Examples

```
## Not run:
waterBalance <- read_MESH_OutputTimeseries_csv("Basin_average_water_balance.csv")
p <- basinStorageVariablesPlot(waterBalance)
# the plot can have a restricted date range
startDate <- as.Date("2005-10-01", format = "%Y-%m-%d")
endDate <- as.Date("2006-09-30", format = "%Y-%m-%d")
library(ggplot2)
p <- p + xlim(startDate, endDate)
p
# you can also change the colours used, either by
# using a defined scale, or by manually specifying them
# This example uses the colours in the package viridis
# which scales from dark to light by reversing the direction
library(viridis)
p <- p + scale_fill_viridis(discrete = TRUE, direction = -1)
p

## End(Not run)
```

basinWaterBalancePlot *Plots basin precipitation cumulative water balance.*

Description

As with the basinRunoffPlot, the cumulative values of precipitation, evaporation and runoff (and optionally, delta storage) are computed by the function, rather than by using the MESH variables. This allows the plot to be used on a sub-set of the basin output data.

Usage

```
basinWaterBalancePlot(basinWaterBalance, accumulate_delta_storage = TRUE)
```

Arguments

basinWaterBalance

Required. Data frame to be plotted. As read in by read_MESH_OutputTimeseries_csv. Note that because the value of DTSG (delta storage) can be negative, you need to set a threshold value much smaller than zero when you read in the values.

accumulate_delta_storage

Optional. If TRUE (the default), the delta storage is accumulated from the beginning of the data set. If FALSE, the delta storage values in the file are *not* accumulated as they are assumed to be cumulative values.

Value

Returns a **ggplot2** line plot of the variable values (mm).

Author(s)

Kevin Shook

See Also[read_MESH_OutputTimeseries_csv](#) [basinStoragePlot](#) [basinSoilWaterIcePlot](#)**Examples**

```
## Not run:
waterBalance <- read_MESH_OutputTimeseries_csv("Basin_average_water_balance.csv",
missingValueThreshold = -1e6)
p <- basinWaterBalancePlot(waterBalance)
## End(Not run)
```

hydroStats

*Calculates Goodness of Fit statistics for MESH output***Description**

This function is a wrapper for the function `gof` in the package **hydroGOF**. It computes several Goodness of Fit statistics for each station. The output of this function may be used on its own, or to annotate a hydrograph.

Usage

```
hydroStats(MESHvals, stationNames = "", calStart = "", calEnd = "",
  removeMissing = TRUE, doSpearman = FALSE, doPBFDC = FALSE,
  digits = 2, j = 1, norm = "sd", s = c(1, 1, 1),
  method = c("2009", "2012"), lq.thr = 0.7, hq.thr = 0.2)
```

Arguments

| | |
|--------------|--|
| MESHvals | Required. A data frame of output from a MESH run, as produced by <code>readOutputTimeseriesCSV</code> . |
| stationNames | Optional. A vector of strings holding station names. If specified, the station names will be used in the returned data frame, otherwise the MESH station numbers will be used. |
| calStart | Optional. The start date of the calibration period. Must be a string in the format 'yyyy-mm-dd'. If specified, values on and after this date will be designated as the Calibration period. The remaining values will be designated as the Validation period. |
| calEnd | Optional. The start date of the calibration period. Must be a string in the format 'yyyy-mm-dd'. If specified, values on and after this date will be designated as the Calibration period. The remaining values will be designated as the Validation period. |

| | |
|----------------------------|--|
| <code>removeMissing</code> | Required. Should rows with missing values be removed before statistics are calculated? Default is TRUE |
| <code>doSpearman</code> | Optional. Should Spearman correlation be computed? Default is FALSE. |
| <code>doPBFDC</code> | Optional. Should percent bias of slope of the midsegment of the FDC be computed? Default is FALSE. |
| <code>digits</code> | Optional. The number of decimal places for rounding goodness of fit statistics. If 0 the default, then it is not set. Default value is 2. Note that percentages like NRMSE and PBIAS will only use a maximum of one decimal place. |
| <code>j</code> | Optional. Argument passed to the <code>mNSE</code> function in hydroGOF . |
| <code>norm</code> | Optional. Argument passed to the <code>nrmse</code> function in hydroGOF . |
| <code>s</code> | Optional. Argument passed to the <code>KGE</code> function in hydroGOF . |
| <code>method</code> | Optional. Argument passed to the <code>KGE</code> function in hydroGOF . |
| <code>lQ.thr</code> | Optional. Argument passed to the <code>pbiassfdc</code> function in hydroGOF . |
| <code>hQ.thr</code> | Optional. Argument passed to the <code>pbiassfdc</code> function in hydroGOF . |

Value

Returns a data frame with the following variables: #'

station station name or number

me Mean Error

mae Mean Absolute Error

mse Mean Squared Error

rmse Root Mean Square Error

nrmse Normalized Root Mean Square Error ($-100\% \leq \text{nrmse} \leq 100\%$)

PBIAS Percent Bias

pbiassfdc PBIAS in the slope of the midsegment of the Flow Duration Curve, if selected

RSR Ratio of RMSE to the Standard Deviation of the Observations, $\text{RSR} = \text{rmse} / \text{sd}(\text{obs})$. ($0 \leq \text{RSR} \leq +\text{Inf}$)

rSD Ratio of Standard Deviations, $\text{rSD} = \text{sd}(\text{sim}) / \text{sd}(\text{obs})$

NSE Nash-Sutcliffe Efficiency ($-\text{Inf} \leq \text{NSE} \leq 1$)

mNSE Modified Nash-Sutcliffe Efficiency

rNSE Relative Nash-Sutcliffe Efficiency

d Index of Agreement ($0 \leq d \leq 1$)

d1 Modified Index of Agreement

rd Relative Index of Agreement

cp Persistence Index ($0 \leq \text{PI} \leq 1$)

r Pearson Correlation coefficient ($-1 \leq r \leq 1$)

r.Spearman Spearman Correlation coefficient ($-1 \leq \text{r.Spearman} \leq 1$), if selected

R2 Coefficient of Determination ($0 \leq \text{R2} \leq 1$).

Gives the proportion of the variance of one variable that is predictable from the other variable

bR2 R2 multiplied by the coefficient of the regression line between sim and obs
($0 \leq \text{bR2} \leq 1$)

KGE Kling-Gupta efficiency between sim and obs
($0 \leq \text{KGE} \leq 1$)

VE Volumetric efficiency between sim and obs
($-\infty \leq \text{VE} \leq 1$)

If the calibration period is specified, then statistics will be computed separately for the Calibration and Validation periods. The period names and dates will be specified in additional columns.

Author(s)

Kevin Shook

See Also

[simpleHydrograph](#) [gof](#)

Examples

```
stats <- hydroStats(MESH_streamflows)
stats$NSE
periodStats <- hydroStats(MESH_streamflows, calEnd = "2010-01-01")
periodStats[,1:7]
```

| | |
|------------------|-----------------------------|
| MESH_streamflows | <i>MESH streamflow data</i> |
|------------------|-----------------------------|

Description

A data frame containing MESH outputs for the Simonette river, as read in using the function `read_MESH_OutputTimeSeries_csv`.

Usage

```
MESH_streamflows
```

Format

A data frame with 4381 rows and 5 variables (including the datetime):

DATE date and time as an R date object

QOMEAS1 measured flows at station 1

QOSIM1 simulated flows at station 1

QOMEAS2 measured flows at station 2

QOSIM2 simulated flows at station 2

Source

This data was obtained by running MESH.

| | |
|-------|-------------------------------------|
| PBIAS | <i>Compute bias as a percentage</i> |
|-------|-------------------------------------|

Description

Compute bias as a percentage

Usage

```
PBIAS(obs, sim)
```

Arguments

| | |
|-----|--|
| obs | Observed values as a numeric vector. |
| sim | Simulated values values as a numeric vector. |

Value

If successful returns the percentage of bias as an integer. If unsuccessful, returns the value FALSE.

Author(s)

Muluneh A. Mekonnen

Examples

```
obs <- runif(100)
sim <- runif(100)
PBIAS(obs, sim)
```

| | |
|--------------|---|
| read_AEP_csv | <i>Reads csv file produced by Alberta Environment and Parks</i> |
|--------------|---|

Description

Reads csv file produced by Alberta Environment and Parks

Usage

```
read_AEP_csv(AEPfile = "", timezone = "", values_only = TRUE)
```

Arguments

| | |
|-------------|---|
| AEPfile | Required. Name of AEP file to be read in. |
| timezone | Optional. The name of the timezone of the data as a character string. If the timezone is not specified, your default value (i.e. your time zone) will be used. This should be the timezone of your data, but omitting daylight savings time. Note that the timezone code is specific to your OS. To avoid problems, you should use a timezone without daylight savings time. Under Windows or OSX, you can use 'etc/GMT+6' or 'etc/GMT+7' for Central Standard and Mountain Standard time. Under Linux you should use 'Etc/GMT+6' or 'Etc/GMT+7'. |
| values_only | Optional. If TRUE (the default), only the time series values will be returned. If FALSE, the meta data will also be returned. |

Value

Returns the time series data as a data frame, with the POSIXct variable `datetime` as the time stamp. Note that the time series interval may be irregular. If `values_only = TRUE`, then the returned value will be a list consisting of the time series data frame and the header meta data as a list.

Author(s)

Kevin Shook

See Also

[read_MESH_OutputTimeseries_csv](#)

Examples

```
## Not run:
precip <- read_AEP_csv("05CA805 Skoki Lodge - PC - C.Merged - All.csv",
all_values = FALSE)
# show values
head(precip$values)
# show latitude
precip$header_meta$latitude
## End(Not run)
```

```
read_MESH_OutputTimeseries_csv
```

Reads MESH output .csv file containing timeseries

Description

Reads a file containing any output from a MASH model into a standard R data frame. The names of the variables will be trimmed to remove leading and trailing spaces, and the time variables are combined into a single R date or datetime.

Usage

```
read_MESH_OutputTimeseries_csv(outputFile, timezone = "",  
  missingValueThreshold = -0.1)
```

Arguments

| | |
|-----------------------|---|
| outputFile | Required. Name of MESH output file. Must be a .csv file. |
| timezone | Not required for daily time series. Required for sub-daily time series. The name of the timezone of the data as a character string. This should be the timezone of your data, but omitting daylight savings time. Note that the timezone code is specific to your OS. To avoid problems, you should use a timezone without daylight savings time. You can use 'etc/GMT+6' or 'etc/GMT+7' for Central Standard and Mountain Standard time, respectively. DO NOT use 'America/Regina' as the time zone, as it includes historical changes between standard and daylight savings time. |
| missingValueThreshold | Optional. Any value smaller than this value will be set to NA_real_ when the file is imported. The default value is -0.1 to prevent zero values from being affected. |

Value

If successful, returns a data frame. The first columns will be called 'DATE' for daily values, and will contain a standard R date. For sub-daily timeseries the first column will be called 'DATETIME' and will contain a standard POSIXct date/time. If unsuccessful, returns the value FALSE.

Author(s)

Kevin Shook

See Also

[simpleHydrograph](#)

Examples

```
## Not run:  
timezone <- 'etc/GMT+6'  
outfile <- "Basin_average_water_balance_ts.csv"  
output <- read_MESH_OutputTimeseries_csv(outfile, timezone)  
## End(Not run)
```

| | |
|-----------------|---------------------------------------|
| read_r2c_raster | <i>Reads r2c file to raster brick</i> |
|-----------------|---------------------------------------|

Description

This function reads a file containing a time series of 2D values, which is output from a MESH model. It is not intended to read in a file describing a drainage basin. For that purpose, you should be using the function `read_r2c_shed`. This function returns either a **raster** brick or an **rts** rts object, which is a timeseries raster. Each Frame in the original file becomes a separate layer. The name of each layer in the **raster** brick is set to the time stamp of each Frame. Because the layer names are standard R variables, they must obey the rules for variable names, including beginning with a character, and not containing spaces. These rule will change the layer names if you are not careful.

Usage

```
read_r2c_raster(r2cFile, NAvalue = NULL, as_rts = FALSE,
  timezone = "", layerNameFormat = NULL)
```

Arguments

| | |
|------------------------------|---|
| <code>r2cFile</code> | Required. Name of r2c file containing time series. |
| <code>NAvalue</code> | Optional. If specified, values smaller than NAvalue will be set to NA_real_ |
| <code>as_rts</code> | Optional. If TRUE, the returned value will be a rts object, which allows the creation of 1-D time series, and for temporal aggregation. If FALSE (the default) a standard raster brick object is returned, which is better for simple plotting of the layers. |
| <code>timezone</code> | Optional. If the <code>r2cFile</code> contains date values for each Frame, then the Frame times are returned as R dates. If there are hours and seconds, then they will be converted to POSIXct datetime values. In this case, you may want to specify the timezone of the data. If the timezone is not specified, your default value will be used. |
| <code>layerNameFormat</code> | Optional. Sets the layer names when returning the raster brick to avoid conflicting with the R variable rules. |

Value

Returns either a **raster** brick or an **rts** rts object.

Author(s)

Kevin Shook

See Also

[rts read_r2c_shed](#)

Examples

```
## Not run:
temps <- read_r2c_raster("TA_M.r2c", NAvalue = 0, as_rts = FALSE, layerNameFormat = "%b_%Y")
# convert air temps from K to C
temps <- temps - 273.15
plot(temps)
# create an animation and save it as a file
library(animation)
saveGIF(animate(temps, n = 1))
## End(Not run)
```

read_r2c_shed

Reads r2c file of a MESH watershed

Description

This function reads in a file containing the layers which define a MESH watershed. To read in a file of timeseries, use the function `r2c2raster`.

Usage

```
read_r2c_shed(r2cFile = "", values_only = TRUE, as_rasters = TRUE)
```

Arguments

| | |
|--------------------------|--|
| <code>r2cFile</code> | Required. Name of r2c file. |
| <code>values_only</code> | Optional. If TRUE (the default), then only the values are returned, either as a raster brick (useful for plotting) or as a 3D array (useful for analysis). If FALSE, then a <i>list</i> will be returned, containing the 1) the data, 2) the metadata (the variable names, types and units) are returned for each layer, and 3) the r2c file header lines. |
| <code>as_rasters</code> | Optional. If TRUE, the layers will be returned as as raster brick. If FALSE, they will be returned as an array. |

Value

Returns either an array or a raster brick of values, and optionally, the meta data and file header.

Author(s)

Kevin Shook

See Also

[read_r2c_raster](#)

Examples

```
## Not run:
# read in basin as a raster brick
basin <- r2c2basin("MESH_drainage_database.r2c")
# read in as an array
basin_array <- r2c2basin("MESH_drainage_database.r2c", as_rasters = FALSE)
# get meta data as well
basin_array <- r2c2basin("MESH_drainage_database.r2c", values_only = FALSE,
as_rasters = FALSE)

## End(Not run)
```

| | |
|----------|------------------------------|
| read_tb0 | <i>Reads a MESH tb0 file</i> |
|----------|------------------------------|

Description

Reads in a tb0 file. The time series values, if present, will be stored in a data frame. Optionally, the meta data will be stored as lists. The meta data are of 2 types, the header values, which refer to the entire file and column values, which pertain to individual columns.

Usage

```
read_tb0(tb0File = "", values_only = TRUE, timezone = "",
NAvalue = NULL)
```

Arguments

| | |
|-------------|---|
| tb0File | Required. The name of the file to be read. |
| values_only | Optional. If TRUE (the default), only the time series values will be returned. If FALSE, the meta data will also be returned. Note that if the value is set to TRUE, and there are no time series values in the file, as for a reservoir file, then an error will result. |
| timezone | Optional. The data time series have POSIXct datetime values. You may want to specify the timezone of the data. If the timezone is not specified, your default value (i.e. your time zone) will be used. |
| NAvalue | Optional. If specified, values smaller than NAvalue will be set to NA_real_ |

Value

Returns time series as a data frame. If meta data are specified, they are returned as a list of header data and a data frame of column meta data. In this case all three sets of data are combined in a single

Author(s)

Kevin Shook

See Also

[read_r2c_raster](#) [read_MESH_OutputTimeseries_csv](#)

Examples

```
## Not run:
qvals <- read_tb02("MESH_input_streamflow.tb0", NAvalue = -0.01, values_only = TRUE)

## End(Not run)
```

| | |
|------------------|--|
| simpleHydrograph | <i>Creates hydrograph from MESH output</i> |
|------------------|--|

Description

Creates a **ggplot** hydrograph from MESH output. This function *only* uses values from a single MESH data frame (as read in using `readOutputTimeseriesCSV`), so does not work with outside sources, such as WSC files. Because this function returns a **ggplot** object, you can change its format in any way you like. The plots produced may be faceted using the commands `facet_wrap` or `facet_grid`.

Usage

```
simpleHydrograph(MESHvals, stationNames = "", byStation = TRUE,
  byYear = FALSE, meas = TRUE, sim = TRUE, calStart = "",
  calEnd = "")
```

Arguments

| | |
|--------------|---|
| MESHvals | Required. A data frame of output from a MESH run, as produced by <code>read_MESH_OutputTimeseries_csv</code> |
| stationNames | Optional. A vector of strings holding station names. If specified, the station names will be used in the plots. Otherwise the MESH station numbers will be used. |
| byStation | Optional. If TRUE (the default) then the plots will be coloured according to the station names. You may want to set this to FALSE if you are facetting by station name. |
| byYear | Optional. If TRUE then the plots will be able to be faceted by year. Note that this means that the dates are all plotted using the year 2000, so you will see strange results if you set this to TRUE and don't facet by year. Default is FALSE |
| meas | Optional. Should the measured values be plotted? Default is TRUE. If FALSE, they will be omitted. |
| sim | Optional. Should the simulated values be plotted? Default is TRUE. If FALSE, they will be omitted. |

| | |
|----------|--|
| calStart | Optional. The start date of the calibration period. Must be a string in the format 'yyyy-mm-dd'. If specified, values on and after this date will be designated as the Calibration period. The remaining values will be designated as the Validation period. |
| calEnd | Optional. The start date of the calibration period. Must be a string in the format 'yyyy-mm-dd'. If specified, values on and after this date will be designated as the Calibration period. The remaining values will be designated as the Validation period. |

Value

If successful, returns a **ggplot2** object. If unsuccessful, returns FALSE. The object can be faceted by the name of the station (the variable is called station). If the option `byYear = TRUE`, then the object can be faceted by the variable YEAR.

Note

Specifying the calibration start and/or end dates will allow the resulting plot to be faceted by the variable period.

Author(s)

Kevin Shook

See Also

[read_MESH_OutputTimeseries_csv](#) [hydroStats](#)

Examples

```
# plot hydrograph of all data on single graph
p1 <- simpleHydrograph(MESH_streamflows)
p1
# add station names, and replot
stations <- c("Station1", "Station2")
p2 <- simpleHydrograph(MESH_streamflows, stationNames = stations)
p2
# remove colouring by station, and facet, changing the axis label format
p3 <- simpleHydrograph(MESH_streamflows, stationNames = stations, byStation = FALSE)
# load in all of ggplot2 to modify plots
library(ggplot2)
p3 <- p3 + facet_wrap(~station, nrow = 2) + scale_x_date(date_labels = "%Y")
p3
# plot by year, then facet
p4 <- simpleHydrograph(MESH_streamflows, stationNames = stations, byYear = TRUE)
p4 <- p4 + facet_wrap(~YEAR, scales = "free_y")
p4
# remove colouring for stations, and facet by station and year
p5 <- simpleHydrograph(MESH_streamflows, stationNames = stations, byStation = FALSE, byYear = TRUE)
p5 <- p5 + facet_grid(YEAR~station, scales = "free_y")
# change colours
```

```
plotcols <- c("red", "blue")
p5 <- p5 + scale_colour_manual(values = plotcols)
p5
```

write_r2c_shed

Write MESH watershed data to r2c file

Description

Write MESH watershed data to r2c file

Usage

```
write_r2c_shed(basin, header, r2cFile = "")
```

Arguments

| | |
|---------|--|
| basin | Required. The values defining the basin parameters, as read in by read_r2c_shed. Can either be an array or a raster brick. |
| header | Required. The header lines from the basin r2c file, as read in by read_r2c_shed |
| r2cFile | Required. The file to be written. |

Value

If successful, returns TRUE. If unsuccessful, returns FALSE

Author(s)

Kevin Shook

See Also

[read_r2c_shed](#)

Examples

```
## Not run:
# read in basin
shed <- read_r2c_shed("MESH_drainage_database.r2c", values_only = FALSE,
as_rasters = FALSE)
# write as another file
write_r2c_shed(shed$basin, shed$header_lines, "new_basin.r2c")

## End(Not run)
```

| | |
|-----------|-------------------------------|
| write_tb0 | <i>Writes a MESH tb0 file</i> |
|-----------|-------------------------------|

Description

Writes a MESH tb0 file

Usage

```
write_tb0(values = NULL, column_meta = NULL, header = NULL,
          NAvalue = -1, tb0File = "")
```

Arguments

| | |
|-------------|--|
| values | Optional. A data frame of the values to be written, if the file is to be a time seired. Note that the first column must be called datetime and must be a POSIXct date/time. |
| column_meta | Required. A data frame containing the following columns #' columnUnits required columnType required columnName required columnLocationX required columnLocationY required DA optional coeff1 optional coeff2 optional coeff3 optional coeff4 optional coeff5 optional |
| header | Required. A list containing the following variables filetype optional, default is tb0 ASCII EnSim 1.0 datatype optional, default is Time Series application optional, default is EnSimHydrologic version optional, default is default is 2.1.23 written_by optional, default is default is MEShr creation_date optional, default is current date/time source_file optional, default is nothing name required projection required, character string ellipsoid required, character string start_time required if values are not specified delta_t required if values are not specified |

| | |
|---------|---|
| | attributeunits optional, default is nothing |
| | unitconversion optional, default is nothing |
| NAvalue | Optional. Value to be used for NA_real_ values in the .tb0 file. The default value is -1, which is not suitable for air temperatures. |
| tb0File | Required. Name of file to be written. |

Value

If successful, returns TRUE. If unsuccessful, returns FALSE

Author(s)

Kevin Shook

See Also

[read_tb0](#)

Examples

```
## Not run: write_tb0(values, column_meta_data, header, "MESH_values.ts0")
```

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