Goodness-of-fit Measures to Compare Observed and Simulated Values with hydroGOF

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1 Installation

Installing hydroGOF:

```
install.packages("hydroGOF")
```

2 Setting up the environment

- Loading the *hydroGOF* library, which contains data and functions used in this analysis.

```
library(hydroGOF)
```

- Loading observed streamflows of the Ega River (Spain), with daily data from 1961-Jan-01 up to 1970-Dec-31

```
require(zoo)
data(EgaEnEstellaQts)
obs <- EgaEnEstellaQts
```

- Generating a simulated daily time series, initially equal to the observed values (simulated values are usually read from the output files of the hydrological model)

```
sim <- obs
```

- Computing the numeric goodness-of-fit measures for the "best" (unattainable) case

```
gof(sim=sim, obs=obs)
```

```
##          [,1]
## ME          0
## MAE         0
## MSE         0
## RMSE        0
## NRMSE %     0
## PBIAS %     0
## RSR         0
## rSD         1
## NSE         1
## mNSE        1
```

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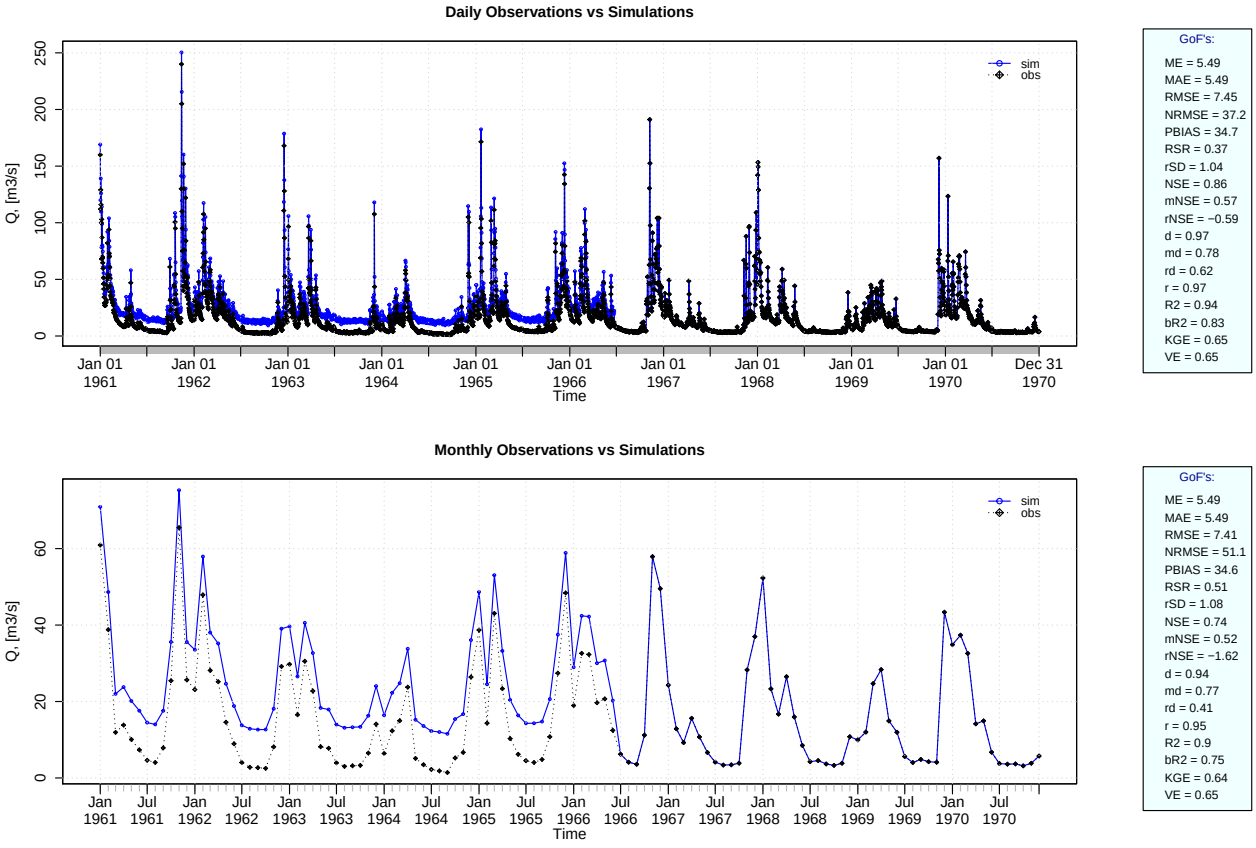
```
## rNSE        1
## d           1
## md          1
## rd          1
## cp          1
## r           1
## R2          1
## bR2         1
## KGE         1
## VE          1
```

- Randomly changing the first 2000 elements of 'sim', by using a normal distribution with mean 10 and standard deviation equal to 1 (default of 'rnorm').

```
sim[1:2000] <- obs[1:2000] + rnorm(2000, mean=10)
```

- Plotting the graphical comparison of 'obs' against 'sim', along with the numeric goodness-of-fit measures for the daily and monthly time series

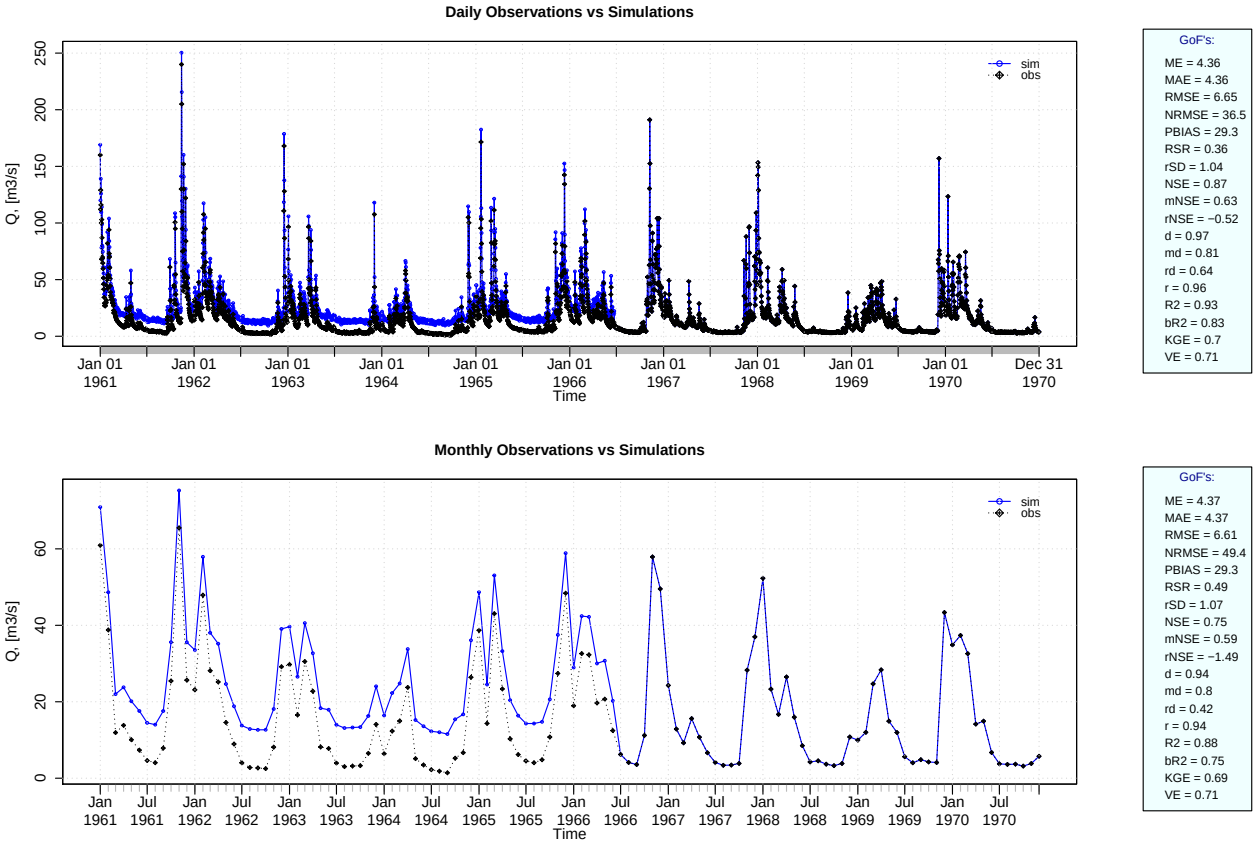
```
ggof(sim=sim, obs=obs, ftype="dm", FUN=mean)
```



2.1 Removing warm-up period

- Using the first two years (1961-1962) as warm-up period, and removing the corresponding observed and simulated values from the computation of the goodness-of-fit measures:

```
ggof(sim=sim, obs=obs, ftype="dm", FUN=mean, cal.ini="1963-01-01")
```



- Verification of the goodness-of-fit measures for the daily values after removing the warm-up period:

```
sim <- window(sim, start=as.Date("1963-01-01"))
obs <- window(obs, start=as.Date("1963-01-01"))

gof(sim, obs)
```

```
##           [,1]
## ME        4.36
## MAE       4.36
## MSE      44.20
## RMSE      6.65
## NRMSE %  36.50
## PBIAS %  29.30
## RSR       0.36
## rSD       1.04
## NSE       0.87
## mNSE      0.63
## rNSE     -0.52
## d         0.97
## md        0.81
## rd        0.64
## cp        0.44
## r         0.96
## R2        0.93
## bR2       0.83
## KGE       0.70
## VE        0.71
```

2.2 Analysis of the residuals

- Computing the daily residuals (even if this is a dummy example, it is enough for illustrating the capability)

```
r <- sim-obs
```

- Summarizing and plotting the residuals (it requires the hydroTSM package):

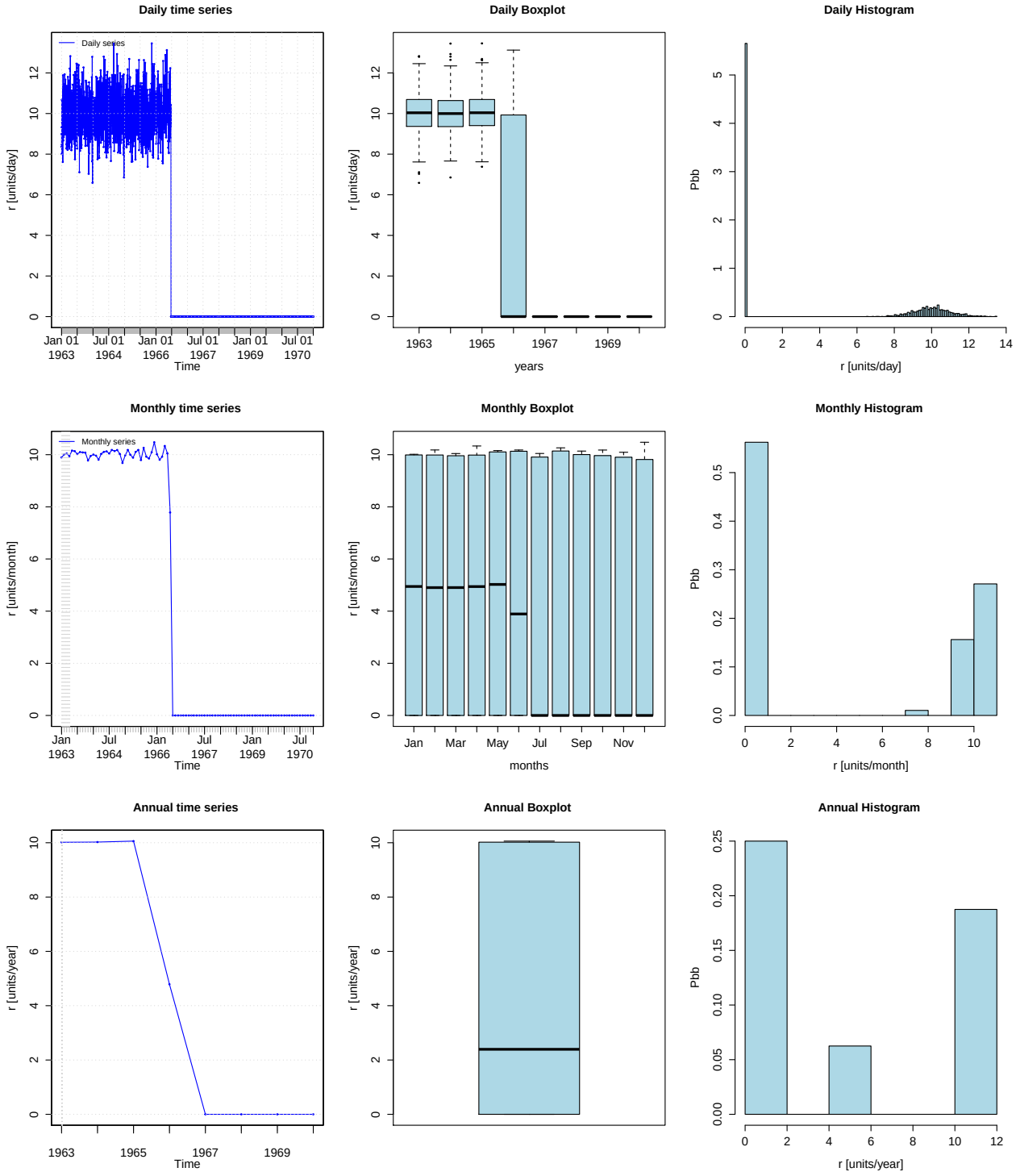
```
library(hydroTSM)
```

```
## Loading required package: xts
```

```
smry(r)
```

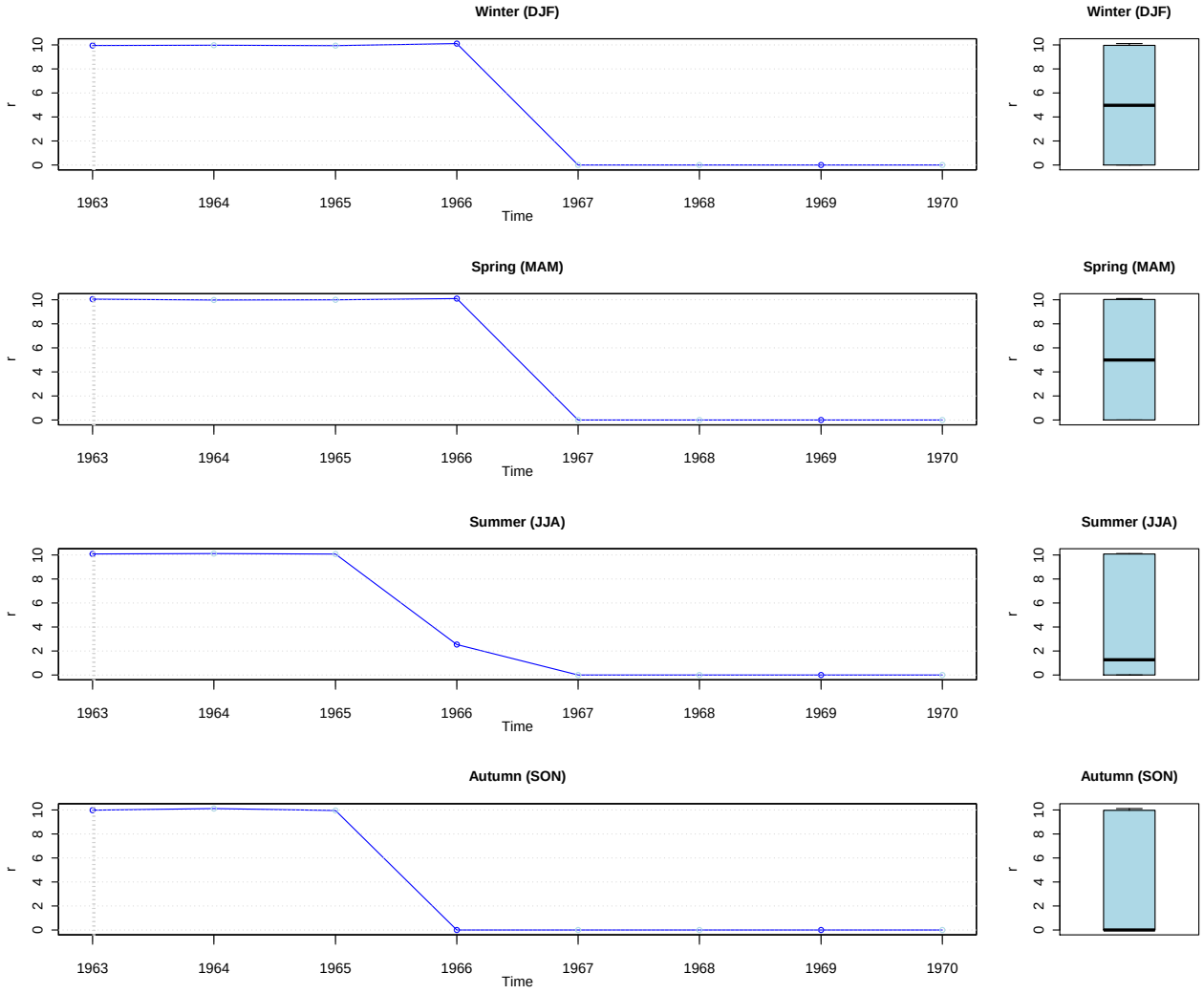
```
##                Index         r
## Min.      1963-01-01    0.0000
## 1st Qu.   1964-12-31    0.0000
## Median    1966-12-31    0.0000
## Mean      1966-12-31    4.3610
## 3rd Qu.   1968-12-30    9.8300
## Max.      1970-12-31   13.4500
## IQR             <NA>    9.8298
## sd              <NA>    5.0187
## cv              <NA>    1.1508
## Skewness        <NA>    0.3159
## Kurtosis        <NA>   -1.8315
## NA's            <NA>    2.0000
## n               <NA> 2922.0000
```

```
# daily, monthly and annual plots, boxplots and histograms
hydroplot(r, FUN=mean)
```



- Seasonal plots and boxplots

```
# daily, monthly and annual plots, boxplots and histograms
hydroplot(r, FUN=mean, pfreq="seasonal")
```



3 Software details

This tutorial was built under:

```
## [1] "x86_64-pc-linux-gnu (64-bit)"
```

```
## [1] "R Under development (unstable) (2020-03-11 r77927)"
```

```
## [1] "hydroGOF 0.4-0"
```

4 Version history

- v0.2: Mar-2020
- v0.1: Aug 2011