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

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

   ```
   > library(hydroGOF)
   ```

2. 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
   ```

3. 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
   ```

4. 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
   ```

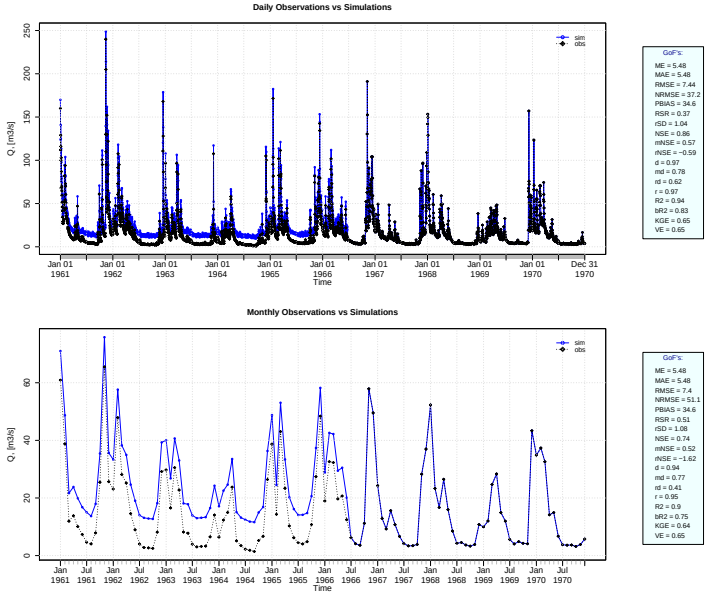
```
RSR         0
rSD         1
NSE         1
mNSE        1
rNSE        1
d           1
md          1
rd          1
cp          1
r           1
R2          1
bR2         1
KGE         1
VE          1
```

5. 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)
```

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

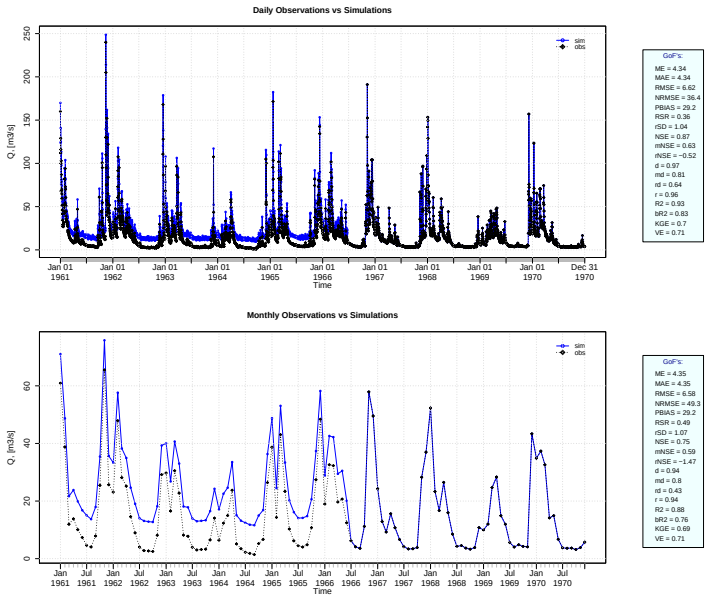
```
> ggof(sim=sim, obs=obs, ftype="dm", FUN=mean)
```



3 Removing Warm-up Period

1. 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")
```



2. 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          4.34
MAE         4.34
MSE        43.87
RMSE        6.62
NRMSE %    36.40
PBIAS %    29.20
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
```

4 Analysis of the Residuals

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

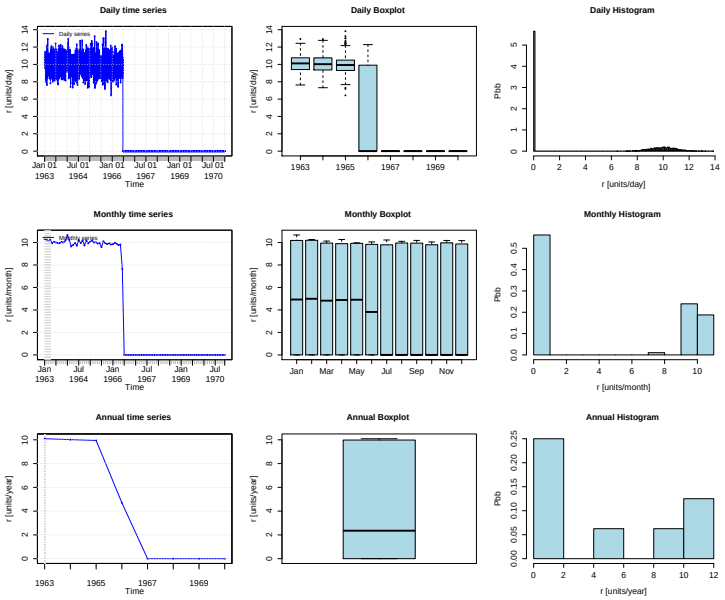
```
> r <- sim-obs
```

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

```
> library(hydroTSM)
> smry(r)
```

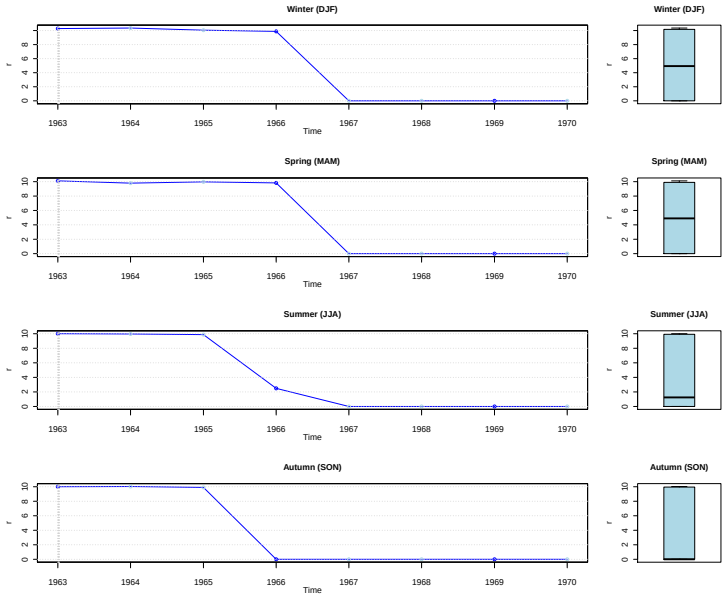
```
                Index         r
Min.       1963-01-01    0.0000
1st Qu.    1964-12-31    0.0000
Median     1966-12-31    0.0000
Mean       1966-12-31    4.3450
3rd Qu.    1968-12-30    9.8200
Max.       1970-12-31   13.8300
IQR               <NA>    9.8200
sd                <NA>    5.0005
cv                <NA>    1.1510
Skewness          <NA>    0.3166
Kurtosis          <NA>   -1.8306
NA's              <NA>    2.0000
n                 <NA> 2922.0000
```

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



3. Seasonal plots and boxplots

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



This tutorial was built under:

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

```
[1] "R version 3.4.1 (2017-06-30)"
```

```
[1] "hydroGOF 0.3-10"
```