

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

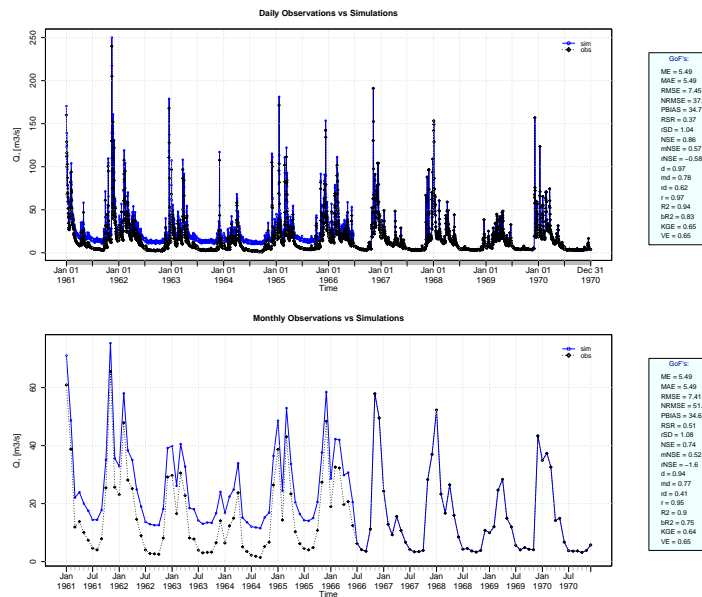
```

- 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

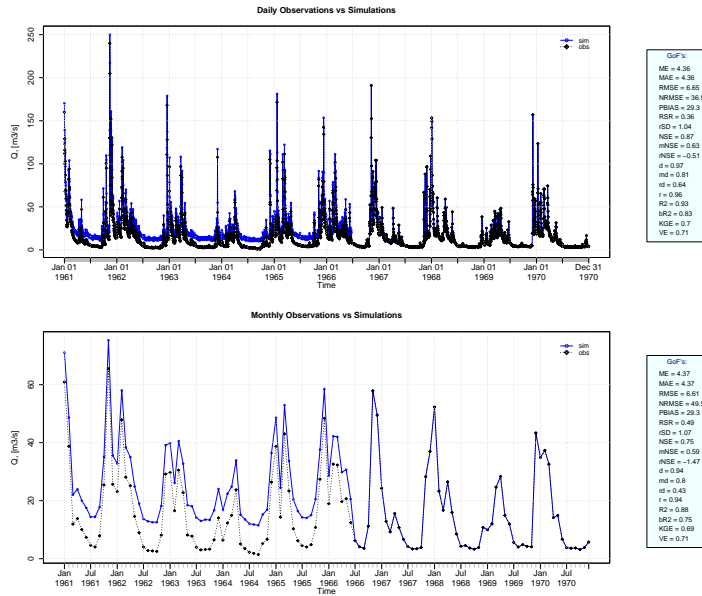
```
> ggof(sim=sim, obs=obs, ftype="dm", FUN=mean)
```



3 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")
```



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      4.36
MAE      4.36
MSE     44.21
RMSE      6.65
NRMSE % 36.50
PBIAS % 29.30
RSR      0.36
rSD      1.04
NSE      0.87
mNSE     0.63
rNSE     -0.51
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)

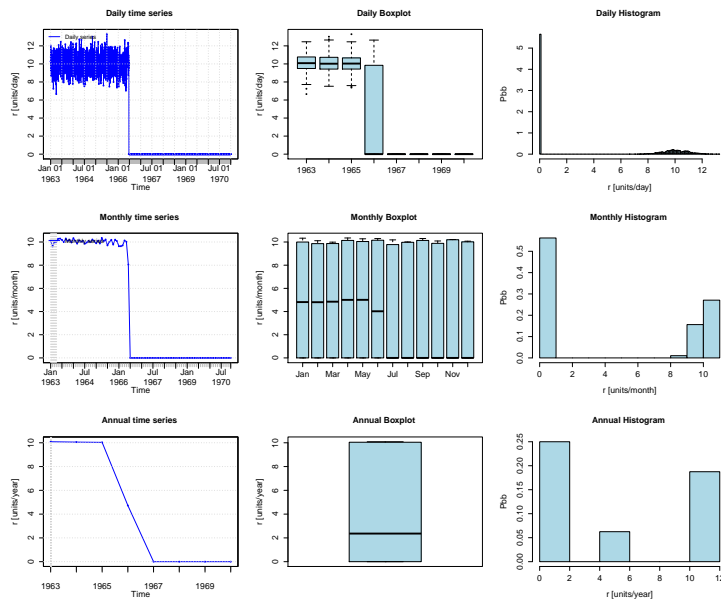
```
> r <- sim-obs
```

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

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

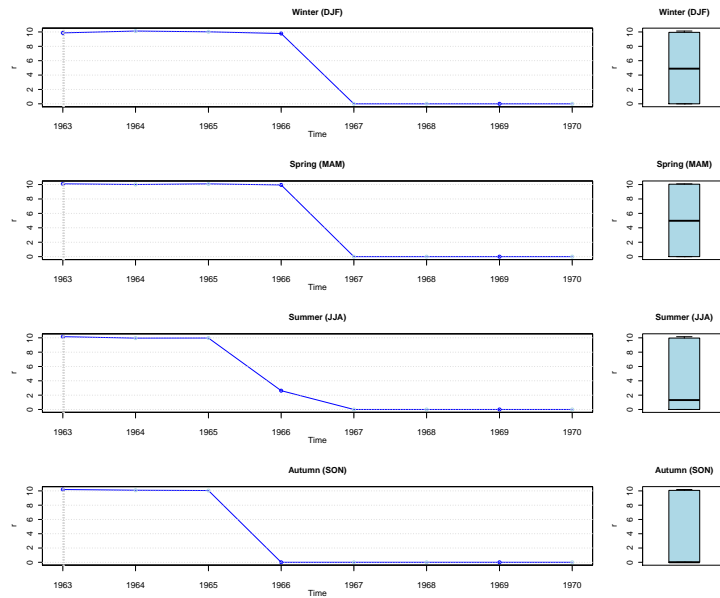
| | Index | r |
|----------|------------|-----------|
| Min. | 1963-01-01 | 0.0000 |
| 1st Qu. | 1964-12-31 | 0.0000 |
| Median | 1966-12-31 | 0.0000 |
| Mean | 1966-12-31 | 4.3630 |
| 3rd Qu. | 1968-12-30 | 9.8490 |
| Max. | 1970-12-31 | 13.2900 |
| IQR | <NA> | 9.8489 |
| sd | <NA> | 5.0185 |
| cv | <NA> | 1.1502 |
| Skewness | <NA> | 0.3125 |
| Kurtosis | <NA> | -1.8394 |
| 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 Under development (unstable) (2018-01-26 r74168)"
```

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