GR is a family of lumped hydrological models designed for flow simulation at various time steps. The models are freely available in an R package called airGR (Coron et al., 2017a, 2017b). The models can easily be implemented on a set of catchments with limited data requirements.

How to use other R packages to perform parameters estimation

- Definition of the necessary function:
  - transformation of parameters to real space (available in airGR)
  - computation of the value of the performance criterion (e.g., RMSE)

  \[
  \text{OptimGR4J} <- \text{function(Param\_Optim)} \\
  \text{Param\_Optim\_Vre} <- \text{airGR::TransfoParam\_GR4J(ParamIn = Param\_Optim, Direction = "TR")}
  \]

- Local optimisation
  - Single-start (here) or multi-start approach to test the consistency of the local optimisation

  \[
  \text{optPORT} \leftarrow \text{stats::nlminb(start = startGR4J, objective = OptimGR4J, lower = lowerGR4J, upper = upperGR4J, control = list(trace = 1))}
  \]

- Global optimisation
  - Most often used when facing a complex response surface, with multiple local minima
  - Differential Evolution

  \[
  \text{optDE} \leftarrow \text{DEoptim::DEoptim(fn = OptimGR4J, lower = lowerGR4J, upper = upperGR4J, control = list(trace = 1))}
  \]

  \[
  \text{Particle Swarm}
  \]

  \[
  \text{optPS} \leftarrow \text{hydropSD::hydropSD(fn = OptimGR4J, lower = lowerGR4J, upper = upperGR4J, control = DEoptim::DEoptim(control = list(trace = 1)))}
  \]

  \[
  \text{MA-LS-Chains}
  \]

  \[
  \text{optMLChains} \leftarrow \text{MA-LS-Chains::MA-LS-Chains(fn = OptimGR4J, max\_Num\_Chains = 2000, lower = lowerGR4J, upper = upperGR4J, control = DEoptim::DEoptim(control = list(trace = 1)))}
  \]

- Results

  \[
  \text{Table of results for different optimisation methods.}
  \]

<table>
<thead>
<tr>
<th>Method</th>
<th>Lower</th>
<th>Upper</th>
<th>Control</th>
<th>Crit Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PORT</td>
<td>256.808</td>
<td>1.004</td>
<td>3.205</td>
<td>0.7852</td>
</tr>
<tr>
<td>DE</td>
<td>256.808</td>
<td>1.004</td>
<td>3.205</td>
<td>0.7852</td>
</tr>
<tr>
<td>PS</td>
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<td>1.004</td>
<td>3.205</td>
<td>0.7852</td>
</tr>
<tr>
<td>MLChains</td>
<td>256.808</td>
<td>1.004</td>
<td>3.205</td>
<td>0.7852</td>
</tr>
</tbody>
</table>

- How to implement the package

  \[
  \text{OptimGR4J} \leftarrow \text{function(Param\_Optim)} \\
  \text{Param\_Optim\_Vre} <- \text{airGR::TransfoParam\_GR4J(ParamIn = Param\_Optim, Direction = "TR")}
  \]

  \[
  \text{Hydrologists:}
  \]

  - easy interface to GR models
  - pre-processing and post-processing tools

  \[
  \text{News since EGU 2017 – airGR 1.09.64 vs airGR 1.05.12}
  \]

  - The \text{Param\_Sets} \_GR4J dataset was added. It contains generalist parameter sets for the GR4J model
  - If the calibration period is too short (< 6 months) and by consequence non-representative of the catchment behaviour, a local calibration algorithm can give poor results and we recommend to use the generalist parameter sets instead
  - Vignettes were added. They explain how to perform parameters estimation with:
    - Differential Evolution calibration algorithm
    - Particle Swarm calibration algorithm
    - MA-LS-Chains calibration algorithm
    - Bayesian MCMC framework
  - A new \text{airGRteaching} package (Delage et al., 2018) provides tools to simplify the use of the airGR hydrological package for education, including a ‘Shiny’ interface

- Future developments

  - New version of CemaNeige that allows to use satellite snow cover area for calibration (Riboulot et al., accepted)
  - Parameters maps on France for GR4J, GR4J & GR6J models for ungauged basins (Poncelet et al., submitted)

References


Download the airGR package

The airGR package is available on the Comprehensive R Archive Network (CRAN): https://CRAN.R-project.org/package=airGR/