Latest developments of the airGR rainfall-runoff modelling R package: new calibration procedures and other features
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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)

  \[
  \text{OptimGR4J} \left( \text{Param}_\text{Optim} \right) \left\{ \\
  \quad \text{Param}_\text{Optim}_\text{Vre} \leftarrow \text{airGR}::\text{TransfoParam}_{\text{GR4J}}(\text{ParamIn} = \text{Param}_\text{Optim}, \\
  \quad \text{Direction} = "TR") \\
  \quad \text{OutputModel} \leftarrow \text{airGR}::\text{RunModel}_{\text{GR4J}}(\text{InputModel} = \text{InputModel}, \\
  \quad \text{RandomParams} = \text{RandOptions}, \quad \text{Param} = \text{Param}_\text{Optim}_\text{Vre}) \\
  \quad \text{OutputsCrit} \leftarrow \text{airGR}::\text{ErrorCrit}_{\text{RMSE}}(\text{InputCrit} = \text{InputCrit}, \\
  \quad \text{OutputModel} = \text{OutputModel}) \\
  \quad \text{return}(\text{OutputsCrit}$_\text{CritValue}) \}
  \]

- Definition of the lower and upper bounds of the four GR4J parameters in the transformed parameter space

  \[
  \text{lowerGR4J} \leftarrow \text{rep}(9.99, \text{times} = 4) \\
  \text{upperGR4J} \leftarrow \text{rep}(49.99, \text{times} = 4)
  \]

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

- Global optimisation
  - Most often used when facing a complex response surface, with multiple local minima
  - Differential Evolution
    \[
    \text{optDE} \left\{ \\
    \quad \text{DEoptim}::\text{DEoptim}(\text{fn} = \text{OptimGR4J}, \\
    \quad \text{lower} = \text{lowerGR4J}, \quad \text{upper} = \text{upperGR4J}, \\
    \quad \text{control} = \text{list}(\text{trace} = 1))
    \]
  - Particle Swarm
    \[
    \text{optPSD} \left\{ \\
    \quad \text{hydPSD}::\text{hydPSD}(\text{fn} = \text{OptimGR4J}, \\
    \quad \text{lower} = \text{lowerGR4J}, \quad \text{upper} = \text{upperGR4J})
    \]
  - MA-LS-Chains
    \[
    \text{optMA} \left\{ \\
    \quad \text{R}::\text{mammalchains}::\text{mammalchains}(\text{fn} = \text{OptimGR4J}, \text{maxCycles} = 2000, \\
    \quad \text{lower} = \text{lowerGR4J}, \quad \text{upper} = \text{upperGR4J})
    \]

- Results

<table>
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<th>Algorithm</th>
<th>Age (yr)</th>
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<th>X(2)</th>
<th>X(3)</th>
<th>X(4)</th>
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</tr>
</tbody>
</table>

Latest developments of the airGR rainfall-runoff modelling R package: new calibration procedures and other features

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NEWS since EGU 2017 – airGR 1.0.9.64 vs airGR 1.0.5.12

- The Para_n_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 airGRteaching package (Delaigue 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 (Ribout et al., accepted)
- Parameters maps on France for GR4J, GR5J & GR6J models for ungauged basins (Poncelet et al., submitted)

References