

# Package ‘GR2MSemiDistr’

May 24, 2021

**Type** Package

**Title** A package for hydrological modeling with a semi-distribute GR2M model adaptation in large-sample studies.

**Version** 3.8.3

**Author** Harold Llauca <hllauca@senamhi.gob.pe>

**Maintainer** Harold Llauca <hllauca@senamhi.gob.pe>

**Description** This package run a semi-distributed GR2M model adaptation using the Weighted Flow Accumulation algorithm in TauDEM\_537 (required)

**License** GPL (>= 2)

**Encoding** UTF-8

**Depends** R (>= 3.6),

**Imports** airGR, foreach, hydroGOF, ncdf4, raster, rgdal, rgeos, rtop, tictoc, lubridate, abind, sf, exactextractr,

**LazyData** true

**RoxygenNote** 7.1.0

## R topics documented:

|                       |          |
|-----------------------|----------|
| Create_Forcing_Inputs | 1        |
| Optim_GR2MSemiDistr   | 3        |
| Routing_GR2MSemiDistr | 4        |
| Run_GR2MSemiDistr     | 5        |
| <b>Index</b>          | <b>7</b> |

---

|                       |   |
|-----------------------|---|
| Create_Forcing_Inputs | <i>Extract and prepare model's inputs data in the airGR format (DatesR, P and E) from gridded P and E monthly data.</i> |
|-----------------------|---|

---

## Description

Extract and prepare model's inputs data in the airGR format (DatesR, P and E) from gridded P and E monthly data.

## Usage

```
Create_Forcing_Inputs(Subbasins, Precip, PotEvap, Qobs = NULL, DateIni,
  DateEnd, Save = FALSE, Update = FALSE, Resolution = 0.01,
  Buffer = 1.1, Members = NULL)
```

## Arguments

|            |   |
|------------|---|
| Subbasins  | Subbasins' shapefile. Must contain the following attributes: 'Area' (in km2), 'Region' (in letters), and 'COMID' (identifier number).     |
| Precip     | Raster brick of the precipitation data in [mm/month].   |
| PotEvap    | Raster brick of the evapotranspiration data in [mm/month].  |
| Qobs       | Observed streamflow data in [m3/s] at the basin outlet. Must have the same length as P and E data (including NA values). NULL as default. |
| DateIni    | Initial date of the database in 'mm/yyyy' format.   |
| DateEnd    | Ending date of the database in 'mm/yyyy' format.  |
| Save       | Boolean to save results as a text file in the 'Outputs' location. FALSE as default.   |
| Update     | Boolean for the updating mode where only the last month's values will be returned. FALSE as default.                                      |
| Resolution | Resampling resolution for improving subbasins' data extraction. 0.01degrees as default.   |
| Buffer     | Factor for increase subbasins' limits extents. 1.1 as default.  |
| Members    | Número de miembros del conjunto modelo. Only for streamflow forecasting purposes. NULL por defecto.                                       |

## Value

Return a dataframe of model's inputs data in the airGR format (DatesR, P, E, Q).

## References

Cesar Aybar, Carlos Fernández, Adrian Huerta, Waldo Lavado, Fiorella Vega & Oscar Felipe-Obando (2020) Construction of a high-resolution gridded rainfall dataset for Peru from 1981 to the present day, Hydrological Sciences Journal, 65:5, 770-785, DOI: 10.1080/02626667.2019.1649411

Llauca H, Lavado-Casimiro W, Montesinos C, Santini W, Rau P. PISCO\_HyM\_GR2M: A Model of Monthly Water Balance in Peru (1981–2020). Water. 2021; 13(8):1048. <https://doi.org/10.3390/w13081048>

## Examples

```
# Load data
require(GR2MSemiDistr)
data(pisco_pr)
data(pisco_pe)
data(qobs)
data(roi)

# Create a database with model's inputs data
data <- Create_Forcing_Inputs(Subbasins=roi,
  Precip=pisco_pr,
  PotEvap=pisco_pe,
  Qobs=qobs,
```

```

DateIni='01/1981',
DateEnd='12/2016')

View(data)

```

---

Optim\_GR2MSemiDistr     *Model parameter optimization with the SCE-UA algorithm.*

---

## Description

Model parameter optimization with the SCE-UA algorithm.

## Usage

```

Optim_GR2MSemiDistr(Data, Subbasins, RunIni, RunEnd, WarmUp = NULL,
  Parameters, Parameters.Min, Parameters.Max, Max.Functions = 5000,
  Optimization = "NSE", No.Optim = NULL)

```

## Arguments

|                |  |
|----------------|--|
| Data           | Dataframe with model input's data in airGR format from Create_Forcing_Inputs. (DatesR, P_1, P_2,...,P_n, E_1, E_2, ...E_n, Q). If Q is not available please provide only DatesR, P, and E.   |
| Subbasins      | Subbasins' shapefile. Must contain the following attributes: 'Area' (in km2), 'Region' (in letters), and 'COMID' (identifier number).  |
| RunIni         | Initial date of the model simulation in 'mm/yyyy' format.  |
| RunEnd         | Ending date of the model simulation in 'mm/yyyy' format.   |
| WarmUp         | Number of months for the warm-up period. NULL as default.  |
| Parameters     | Vector of initial model parameters (X1 and X2) and correction factors of P (fp) and E (fpe) in the following order: c(X1, X2, fp, fpe). In the case of existing more than one 'Region' (e.g. regions A and B) please provide model parameters in the following order: c(X1_A, X1_B, X2_A, X2_B, Fp_a, Fp_B, Fpe_A, Fpe_B). |
| Parameters.Min | Vector of minimum values of GR2M model parameters and correction factors in the following order: c(X1_min, X2_min, fp_min, fpe_min).   |
| Parameters.Max | Vector of maximum values of GR2M model parameters and correction factors in the following order: c(X1_max, X2_max, fp_max, fpe_max).   |
| Max.Functions  | Maximum number of function evaluation for optimization. 5000 as default.   |
| Optimization   | Objective function for optimization (NSE, KGE, or RMSE).   |
| No.Optim       | Regions not to be optimized. NULL as default.  |

## Value

List of optimal GR2M model parameters for each 'Region'.  
Param: Best set of GR2M model parameters (sorted by 'Region').  
Value: Final value of the objective function.

## References

Llauca H, Lavado-Casimiro W, Montesinos C, Santini W, Rau P. PISCO\_HyM\_GR2M: A Model of Monthly Water Balance in Peru (1981–2020). *Water*. 2021; 13(8):1048. <https://doi.org/10.3390/w13081048>

## Examples

```
# Optimize GR2M model parameters for a single 'Region' using the KGE metric
optim <- Optim_GR2MSemiDistr(Data=data,
                             Subbasins=roi,
                             RunIni='01/1981',
                             RunEnd='12/2002',
                             WarmUp=36,
                             Parameters=c(1000, 1, 1, 1),
                             Parameters.Min=c(1, 0.01, 0.8, 0.8),
                             Parameters.Max=c(2000, 2, 1.2, 1.2),
                             Max.Functions=1000,
                             Optimization='KGE')

best_param <- optim$Param
```

---

Routing\_GR2MSemiDistr    *Routing discharges for each subbasin.*

---

## Description

Routing discharges for each subbasin.

## Usage

```
Routing_GR2MSemiDistr(Model, Subbasins, Dem, AcumIni = NULL,
                      AcumEnd = NULL, Save = FALSE, Update = FALSE)
```

## Arguments

|           |   |
|-----------|---|
| Model     | List of model results from Run_GR2MSemiDistr.   |
| Subbasins | Subbasins' shapefile. Must contain the following attributes: 'Area' (in km2), 'Region' (in letters), and 'COMID' (identifier number). |
| Dem       | Digital elevation model raster for the extent of the basin.   |
| AcumIni   | Initial date of the model routing in 'mm/yyyy' format. NULL as default  |
| AcumEnd   | Ending date of the model routing in 'mm/yyyy' format. NULL as default   |
| Save      | Boolean to save results as a text file in the 'Outputs' location. FALSE as default.   |
| Update    | Boolean for the updating mode where only the last month's values will be returned. FALSE as default.                                  |

## Value

List of model routing outputs.

QR: Routed discharge timeseries for all subbasins in [m3/s].

Dates: Vector of dates of the simulation period.

COMID: Vector of identifier numbers for each subbasin.

**Author(s)**

Llauca H, Lavado-Casimiro W, Montesinos C, Santini W, Rau P. PISCO\_HyM\_GR2M: A Model of Monthly Water Balance in Peru (1981–2020). *Water*. 2021; 13(8):1048. <https://doi.org/10.3390/w13081048>

**Examples**

```
# Load data
require(GR2MSemiDistr)
data(dem)

# Routing discharges in the streamflow network
rou <- Routing_GR2MSemiDistr(Model=model,
                             Subbasins=roi,
                             Dem=dem,
                             AcumIni='01/1981',
                             AcumEnd='12/2016')

View(rou$QR)
```

---

|                   |  |
|-------------------|--|
| Run_GR2MSemiDistr | <i>Run the GR2M model for 'n' subbasins.</i> |
|-------------------|--|

---

**Description**

Run the GR2M model for 'n' subbasins.

**Usage**

```
Run_GR2MSemiDistr(Data, Subbasins, RunIni, RunEnd, WarmUp = NULL,
                  Parameters, IniState = NULL, Save = FALSE, Update = FALSE)
```

**Arguments**

|            |  |
|------------|--|
| Data       | Dataframe with model input's data in airGR format from <code>Create_Forcing_Inputs</code> . (DatesR, P_1, P_2,...,P_n, E_1, E_2, ...E_n, Q). If Q is not available please provide only DatesR, P, and E.   |
| Subbasins  | Subbasins' shapefile. Must contain the following attributes: 'Area' (in km2), 'Region' (in letters), and 'COMID' (identifier number).  |
| RunIni     | Initial date of the model simulation in 'mm/yyyy' format.  |
| RunEnd     | Ending date of the model simulation in 'mm/yyyy' format.   |
| WarmUp     | Number of months for warm-up. NULL as default.   |
| Parameters | Vector of model parameters (X1 and X2) and correction factors of P (fp) and E (fpe) in the following order: c(X1, X2, fp, fpe). In the case of existing more than one 'Region' (e.g. regions A and B) please provide model parameters in the following order: c(X1_A, X1_B, X2_A, X2_B, Fp_a, Fp_B, Fpe_A, Fpe_B). |
| IniState   | Initial states variables. NULL as default.   |
| Save       | Boolean to save results as a text file in the 'Outputs' location. FALSE as default.  |
| Update     | Boolean for the updating mode where only the last month's values will be returned. FALSE as default.   |

**Value**

List of GR2M model outputs.

PR: Precipitation timeseries for all subbasins in [mm/month].

AE: Actual evapotranspiration timeseries for all subbasins in [mm/month].

SM: Soil Moisture timeseries for all subbasins in [mm/month].

RU: Runoff timeseries for all subbasins in [mm/month].

QS: Discharge timeseries for all subbasins in [m3/s] (not routed).

Dates: Vector of dates of the simulation period.

COMID: Vector of identifier numbers for each subbasin.

EndState: List of end model states of each subbasin.

SINK: Basin outlet which contains qsim and qobs data time series in [m3/s].

**References**

Llauca H, Lavado-Casimiro W, Montesinos C, Santini W, Rau P. PISCO\_HyM\_GR2M: A Model of Monthly Water Balance in Peru (1981–2020). *Water*. 2021; 13(8):1048. <https://doi.org/10.3390/w13081048>

**Examples**

```
# Run the GR2M model for each subbasin
model <- Run_GR2MSemiDistr(Data=data,
                           Subbasins=roi,
                           RunIni='01/1981',
                           RunEnd='12/2016',
                           Parameters=c(10.976, 0.665, 1.186, 1.169))

# Extract model results
View(model$PR) # precipitation [mm/month]
View(model$AE) # actual evapotranspiration [mm/month]
View(model$SM) # soil moisture [mm/month]
View(model$RU) # runoff in [mm/month]
print(model$SINK$qobs) # observed discharge in [m3/s] at basin outlet
print(model$SINK$qsim) # simulated discharge in [m3/s] at basin outlet
```

# Index

Create\_Forcing\_Inputs, [1](#)

Optim\_GR2MSemiDistr, [3](#)

Routing\_GR2MSemiDistr, [4](#)

Run\_GR2MSemiDistr, [5](#)