



U.R. Hydrosystems and Bioprocesses

Internship offer
University year 2017-2018

1. **Title**

Comparison of hydrological modelling R packages
Comparaison des packages R de modélisation hydrologique

2. **Internship type**

Internship of Master level or last year of engineering school

3. **Period – Duration**

5 to 6 months during the first semester 2018.

4. **Lab and supervisor**

Lab:

Irstea
UR Hydrosystèmes et Bioprocédés
1, rue Pierre-Gilles de Gennes CS 10030
92761 Antony Cedex, France
Web: <http://www.irstea.fr/en/institute/centers/antony>

Supervisor:

Guillaume Thirel
Tel: +33 1 40 96 65 69
Email: guillaume.thirel@irstea.fr
Web: <http://webgr.irstea.fr>
Other supervisors: Juraj Parajka and Alberto Viglione (TU Wien), Olivier Delaigue (Irstea)

5. **Wage**

Monthly maximal wage: 554.40 €

6. **Profile**

- Strong skills and motivation in R programming
- Strong skills in hydrological modelling
- Good skills in team working
- Good level of English is necessary because this internship is an international collaboration, good level of French is an advantage
- Good writing skills

7. **Mission of the internship**

• **Context**

Hydrological modelling is a powerful tool for engineering as well as research purposes. It enables analysing the processes describing the rainfall-runoff relationship, simulating discharges where no gauge stations are available, making predictions or anticipating the impact of climate change on the water cycle.

R is a free software environment that is available on the main platforms. In R, free packages, i.e. libraries of functions with a determined goal, are developed in universities and others institutes or companies. More specifically, the use of R and the number of packages aimed at the science of hydrology are increasingly growing. For example, Irstea and TU Wien developed their own R

packages, which contain the hydrological models they developed, respectively airGR¹ (Coron et al., 2017) including GR4J and TUWmodel² (Viglione and Parajka, 2016) based on HBV.

```
> example("TUWmodel")
TUWmdl> ## Load the data
TUWmdl> data(example_TUWmodel)
TUWmdl> ## Simulate runoff and plot observed vs simulated series
TUWmdl> ## Lumped case (weighted means of the inputs)
TUWmdl> simlump <- TUWmodel(prec=apply(P_Vi1s, 1, weighted.mean, w=areas_Vi1s),
TUWmdl+   air=apply(T_Vi1s, 1, weighted.mean, w=areas_Vi1s),
TUWmdl+   ep=apply(PET_Vi1s, 1, weighted.mean, w=areas_Vi1s),
TUWmdl+   areas=sum(areas_Vi1s),
TUWmdl+   param=c(1.02,1.70,2.0,-0.336,
TUWmdl+   0.934,121,2.52,
TUWmdl+   0.473,9.06,142,
TUWmdl+   50,1,2.38,10,25))
TUWmdl> plot(as.Date(names(Q_Vi1s)), Q_Vi1s, type="l", xlab="", ylab="Discharges [mm/day]")

> example("RunModel_GR4J")
RM_GR4> library(airGR)
RM_GR4> ## Loading catchment data
RM_GR4> data(L0123001)
RM_GR4> ## preparation of the InputsModel object
RM_GR4> InputsModel <- CreateInputsModel(FUN_MOD = RunModel_GR4J, DatesR = Basinobs$DatesR,
RM_GR4+   Precip = Basinobs$P, PotEvap = Basinobs$E)
RM_GR4> ## run period selection
RM_GR4> Ind_Run <- seq(which(Format(Basinobs$DatesR, format = "%d/%m/%Y %H:%M")=="01/01/1990 00:00"),
RM_GR4+   which(Format(Basinobs$DatesR, format = "%d/%m/%Y %H:%M")=="31/12/1999 00:00"))
RM_GR4> ## preparation of the RunOptions object
RM_GR4> RunOptions <- CreateRunOptions(FUN_MOD = RunModel_GR4J,
RM_GR4+   InputsModel = InputsModel, IndPeriod_Run = Ind_Run)
RM_GR4> ## simulation
RM_GR4> Param <- c(257.238, 1.012, 88.235, 2.208)
RM_GR4> OutputsModel <- RunModel_GR4J(InputsModel = InputsModel, RunOptions = RunOptions, Param = Param)
RM_GR4> ## results preview
RM_GR4> plot(OutputsModel, Qobs = Basinobs$Qmm[Ind_Run])
```

Figure 1: examples of the code for running two hydrological R packages (TUWmodel and airGR).

- **Objectives of the internship**

The main objective of the internship is to analyse the diverse hydrological modelling R packages that exist. These packages propose models that have different spatial or temporal resolutions, data requirements and concepts. The student will be asked to identify the different packages that allow making simulations of discharge³, especially at the daily time step. The characteristics of these packages and models will need to be identified. Finally, the performances of the packages will be analysed within a common framework in terms of error metrics and computational time.

The intern will be mainly based at Irstea in Antony. If necessary, a stay at TU Wien (Austria) will be organised.

- **Methodology**

The first step will be to take in charge airGR and TUWmodel. Then, it will be necessary to identify all the available R packages and to analyse their characteristics. The third step will be to define a framework that will allow comparing them and to prepare the database that will be used for it (Irstea and TU Wien already have their databases, which could be useful for this step). Finally, the packages will be run and their outputs will be analysed.

A report will be written in English. If the results deserve it, an article will be written and submitted in a peer-review journal.

- **Bibliography**

Coron, L., Thirel, G., Delaigue, O., Perrin, C., Andréassian, V., 2017: The Suite of Lumped GR Hydrological Models in an R package, Environmental Modelling & Software, 94, 166-171, DOI: 10.1016/j.envsoft.2017.05.002.

Viglione, A. and Parajka, J., 2016. TUWmodel: Lumped Hydrological Model for Education Purposes. R package version 0.1-8. <https://CRAN.R-project.org/package=TUWmodel>

¹ <https://cran.r-project.org/web/packages/airGR/index.html>

² <https://cran.r-project.org/web/packages/TUWmodel/index.html>

³ Some examples are airGR, TUWmodel, dynatopmodel, Ecohydmod, topmodel, hydromad