I.S.RIVERS
LYON 2018

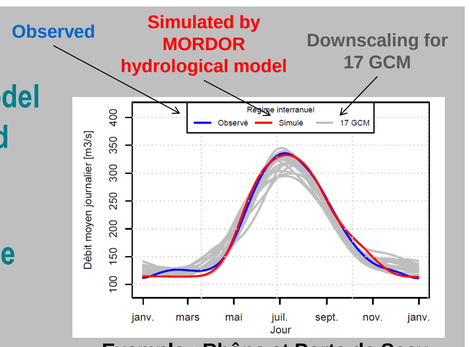
RHÔNE RIVER WATER DISCHARGE PROJECTIONS UNTIL 2100, UNDER THE PRESSURE OF CLIMATE CHANGES

Projections de débits du fleuve Rhône à l'horizon de 2100 dans le cadre du Changement Climatique

In the context of global change, assessment of climate changes incidence becomes a key parameter to take into account for today and future water resource management at the scale of large river basin. For the Rhône River basin, evaluation of future behavior of water resources are especially difficult, because of the diversity of the hydrological regime observed for its tributaries (rainfall, snow and glacier melt) and the diversity of water uses (irrigation, energy…). Our work proposes water discharge projections for different locations on the upper part of the Rhône River flow (until Pont de Viviers, meaning 70% of the entire Rhône River basin) for 2015 to 2100.

Highlights:

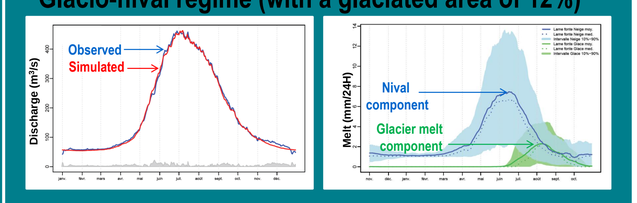
- Glacier melt properly modeled by MORDOR hydrological model
- Validation of downscaling method performance for the period 1981-2000 (17 GCM)
- Main climatic change predicted for 2046-2065 period: contrast between the upper part and the lower part of the Rhône basin, mainly explained by a competition between glacier melt contribution and evapo-transpiration rates, process strongly driven by air temperature increase



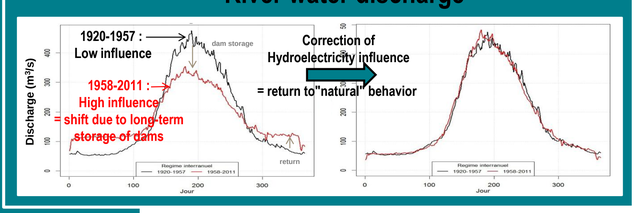
Example : Rhône at Porte de Scex (period 1981-2000)

Focus on the upper Rhône River watershed

Glacio-nival regime (with a glaciated area of 12%)



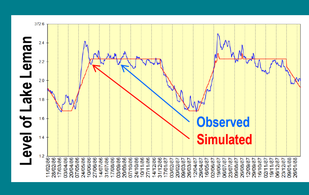
Impact of hydroelectricity generation on Rhône River water discharge



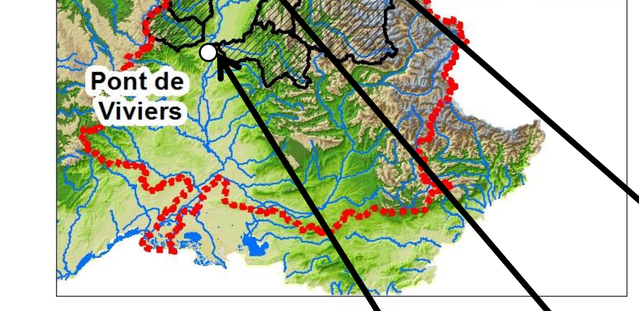
Focus on natural hydrology and management scheme of the Lake Leman

Rhône River is a transboundary river, strongly dependent on governance issues between France and Switzerland (Lake Leman and Arve river).

Thus management scheme of Lake Leman has been included in the catchment modeling.



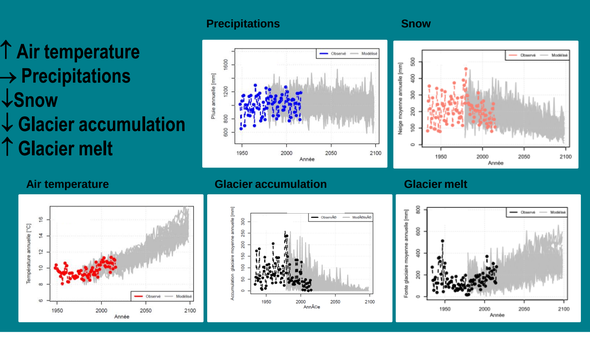
Water management of Lake Leman presents sources of uncertainties in the future, especially due to sharing of water resources that is the subject of transboundary discussions. In our analysis, we took into account a steady state scenario for the regulated outlet discharge from Lake Leman.



Focus on hydrological model projections outputs, under climate changes

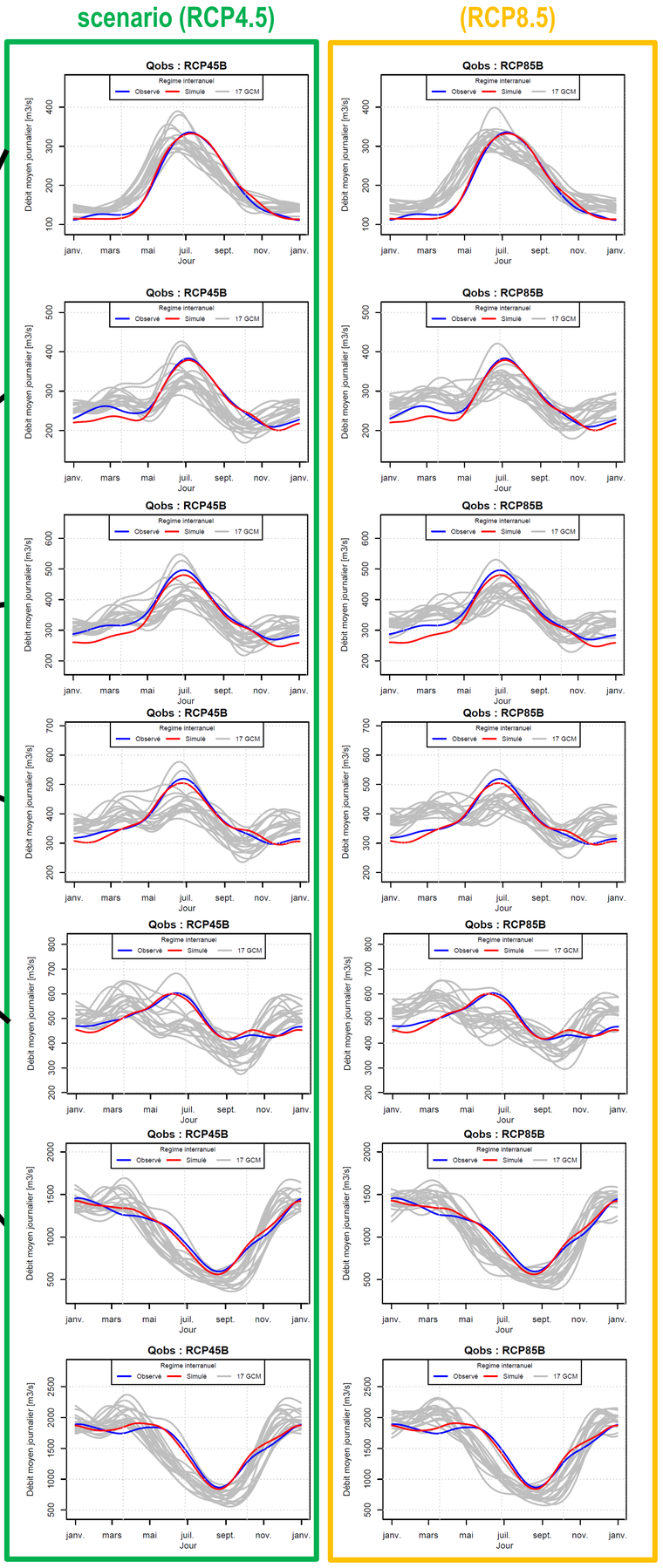
Example : Rhône at Porte de Scex for RCP8.5

↑ Air temperature
→ Precipitations
↓Snow
↓ Glacier accumulation
↑ Glacier melt



Rhône river water discharge projections 2046-2065 under 2 scenarios (RCP4.5 and RCP8.5) for 17 General Circulation Models (GCM) of the latest generation of IPCC AR5 CMIP5 compared to observed (CNR data for the french part) and simulated discharge 1981-2000

Medium mitigation scenario (RCP4.5) | **High emission scenario (RCP8.5)**



Porte de Scex

- Glacio-nival regime influenced by hydroelectricity
- Decrease in the summer peak flow and an early start of the melt driven peak flow
- Higher discharge for low flow period during the winter
- 1981-2000 period (≈ 200 m³/s) ➔ 2046-2065 period : +0.8%* (RCP4.5) ; +7%* (RCP8.5)

Geneva

- Pluvio-nival regime influenced by management scheme of the Lake Leman
- Decrease in the summer peak flow and an early start of the melt driven peak flow
- Higher discharge for low flow period during the winter
- 1981-2000 period (≈ 270 m³/s) ➔ 2046-2065 period : -1.3%* (RCP4.5) ; +3%*(RCP8.5)

Pougny

- Pluvio-nival regime influenced
- Decrease in the summer peak flow
- Higher discharge for low flow period during the winter
- 1981-2000 period (≈ 330 m³/s) ➔ 2046-2065 period : -0.1%* (RCP4.5) ; +4.3%* (RCP8.5)

Bognes

- Pluvio-nival regime influenced
- Decrease in the summer peak flow
- Higher discharge for low flow period during the winter
- 1981-2000 period (≈ 375 m³/s) ➔ 2046-2065 period : -0.9%* (RCP4.5) ; +3%* (RCP8.5)

Lagnieu

- Pluvio-nival regime influenced
- Discharge for low flow period at the end of the summer likely to decrease
- Discharge for low flow period during the winter likely to increase
- 1981-2000 period (≈ 480 m³/s) ➔ 2046-2065 period : -3.1%* (RCP4.5) ; -0.3%* (RCP8.5)

Ternay

- Pluvial regime
- Significant lower discharge for low flow period during summer
- Discharge for high flow period during winter likely to increase
- 1981-2000 period (≈ 1050 m³/s) ➔ 2046-2065 period : -7.4%* (RCP4.5) ; -6.5%* (RCP8.5)

Pont de Viviers

- Pluvial regime
- Significant lower discharge for low flow period during summer
- Discharge for high flow period during winter likely to increase
- 1981-2000 period (≈ 1600 m³/s) ➔ 2046-2065 period : -6.4%* (RCP4.5) ; -6.0%* (RCP8.5)

* Median value calculated for the 17 GCM

Hydro-climatic projections have been proceeded, including hydrological modeling (MORDOR, semi-distributed hydrological model) and climatic projections from CMIP5 (5th Coupled Model Intercomparison Project) experiments used by the Intergovernmental Panel on Climate Change (IPCC). Results are presented here as water discharge trajectories taking into account 2 scenarios emission of greenhouse gases (RCP4.5, a medium mitigation scenario and RCP8.5, also called « Business as usual » scenario) and 17 General Circulation Models (GCM), shared among the scientific community.

Agnès Brenot[1], Joël Gailhard[1], Matthieu Le Lay[1], Cécile Martinet[1], Amélie Joly[2], Lucie Meier[2], Paul-Antoine Michelangeli[2]
[1]EDF-DTG, Département Surveillance, 21 avenue de l'Europe BP41 38 040 Grenoble France (agnes.brenot@edf.fr ; cecile.martinet@edf.fr) ; [2]EDF-R&D, 6 quai Wattier 78 400 CHATOU