Future changes in hydrological extremes of a Mediterranean catchment: what can we say in an uncertainty context?

Lila Collet, Thibault Lemaitre-Basset, Guillaume Thirel, Juraj Parajka, Guillaume Evin, and Benoît Hingray

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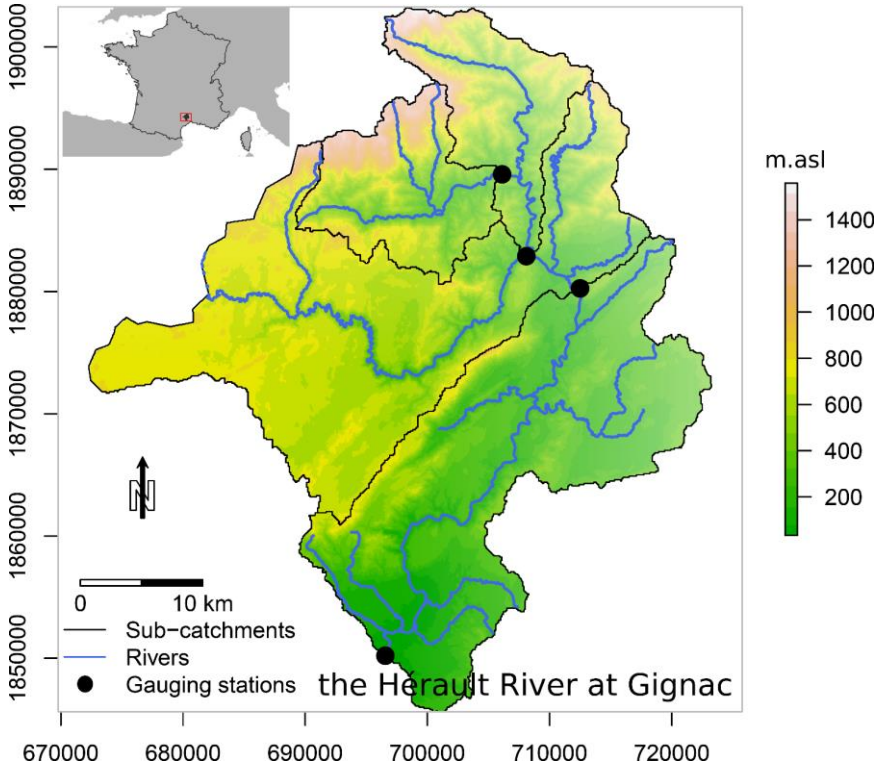
The Mediterranean in a global context

Climate change hot-spot, growing population and increasing water use tensions!

Research questions:

- How will hydrological extremes change with climate change?
- How can we characterize the uncertainty deriving from impact studies?
- What are the main sources of uncertainty for high- and low-flows?

Case study: The Hérault River catchment, Southern France



Method

Cascade of uncertainty: multi-model multi-scenario approach

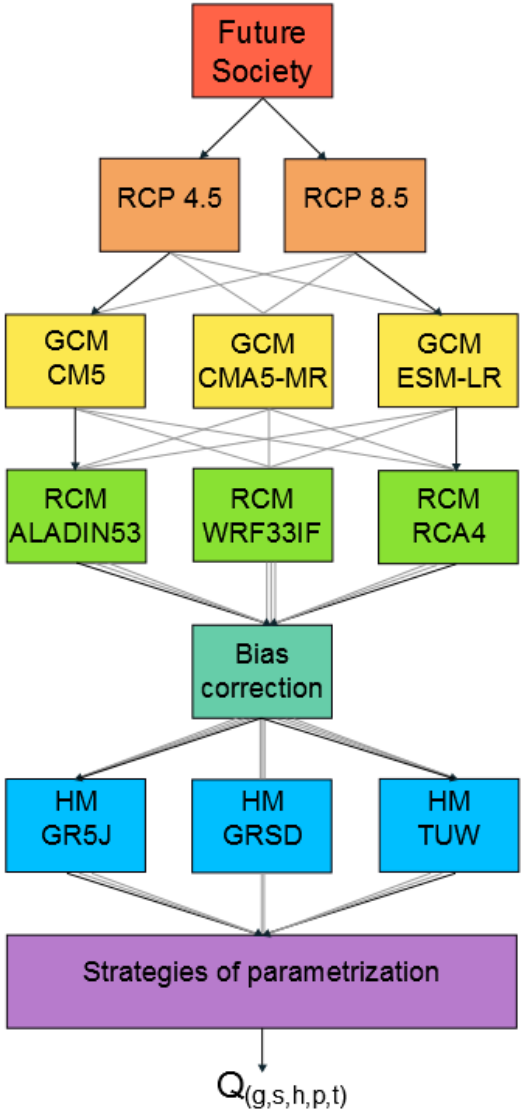
2 RCPs, 5 GCM/RCM couples, 3 hydrological models, 29 calibration procedures

→ **870 runoff projections**

Uncertainty quantification and partitioning: **QUALYPSO** (Evin et al., 2019)

Baseline period: 1976-2005

Future period: 2006-2100

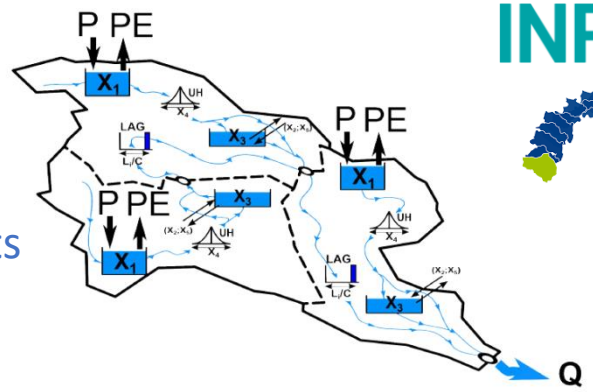


Hydrological models

3 bucket-type hydrological models, daily time-step:

GRSD:

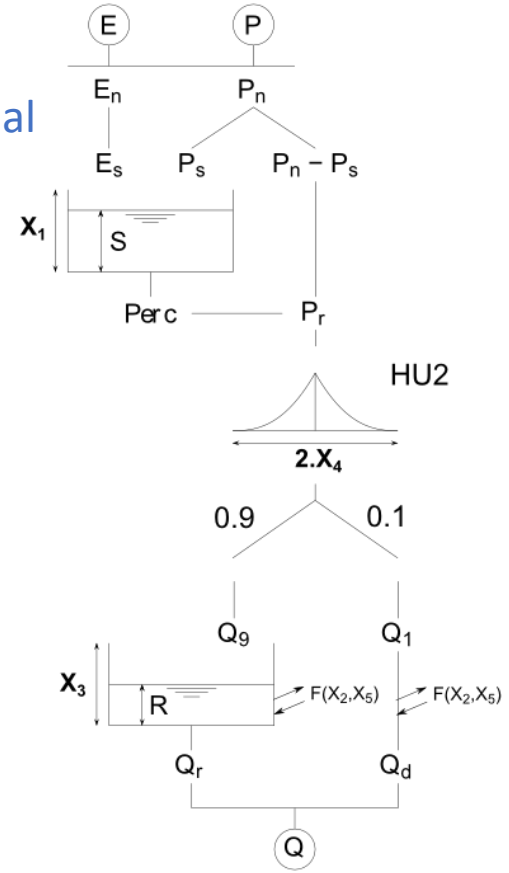
Conceptual
Semi-distributed
on subcatchments



INRAE HYDRO

GR5J:

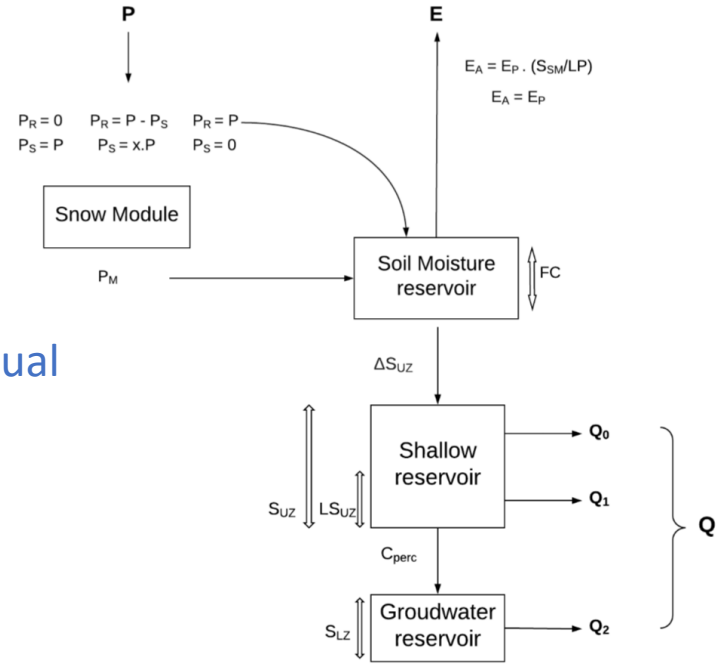
Conceptual
Lumped



TU WIEN

TUW:

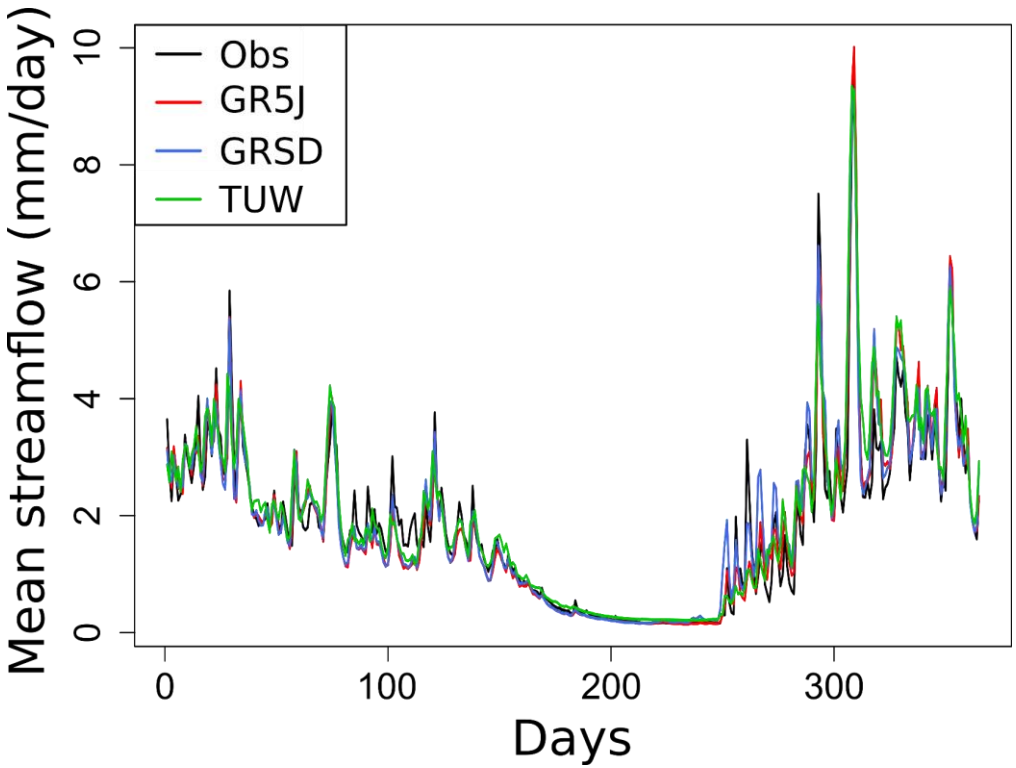
Conceptual
Lumped

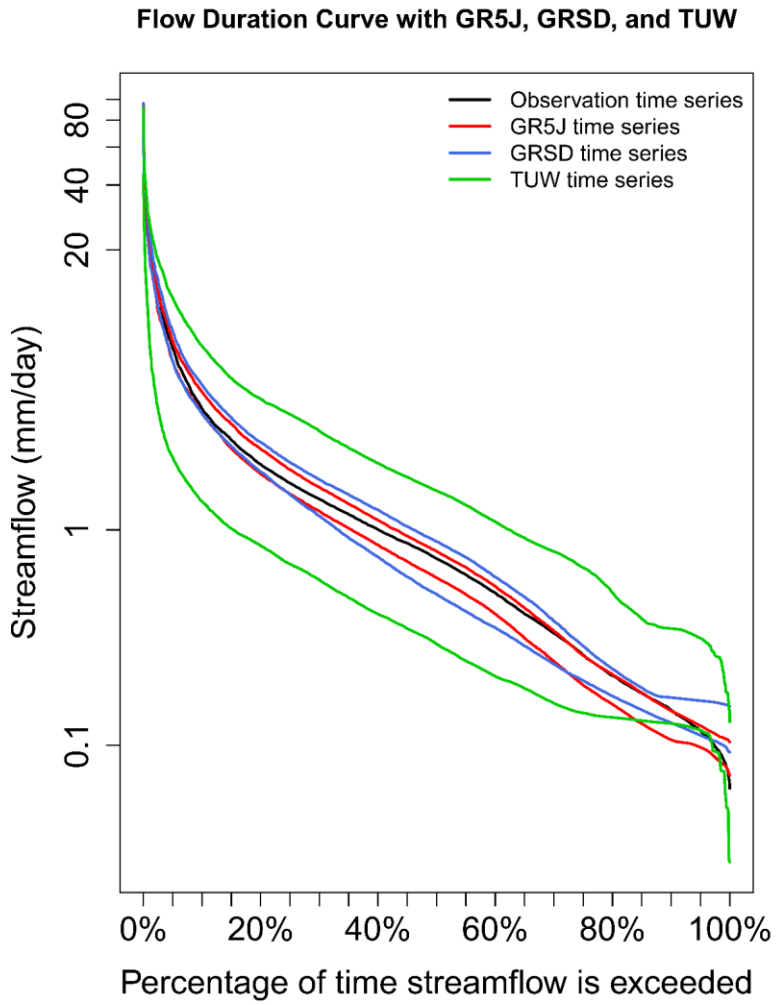


Calibration performances

29 calibration procedures were performed over 1992-2018.

10th and 90th percentiles of the simulation ensembles:

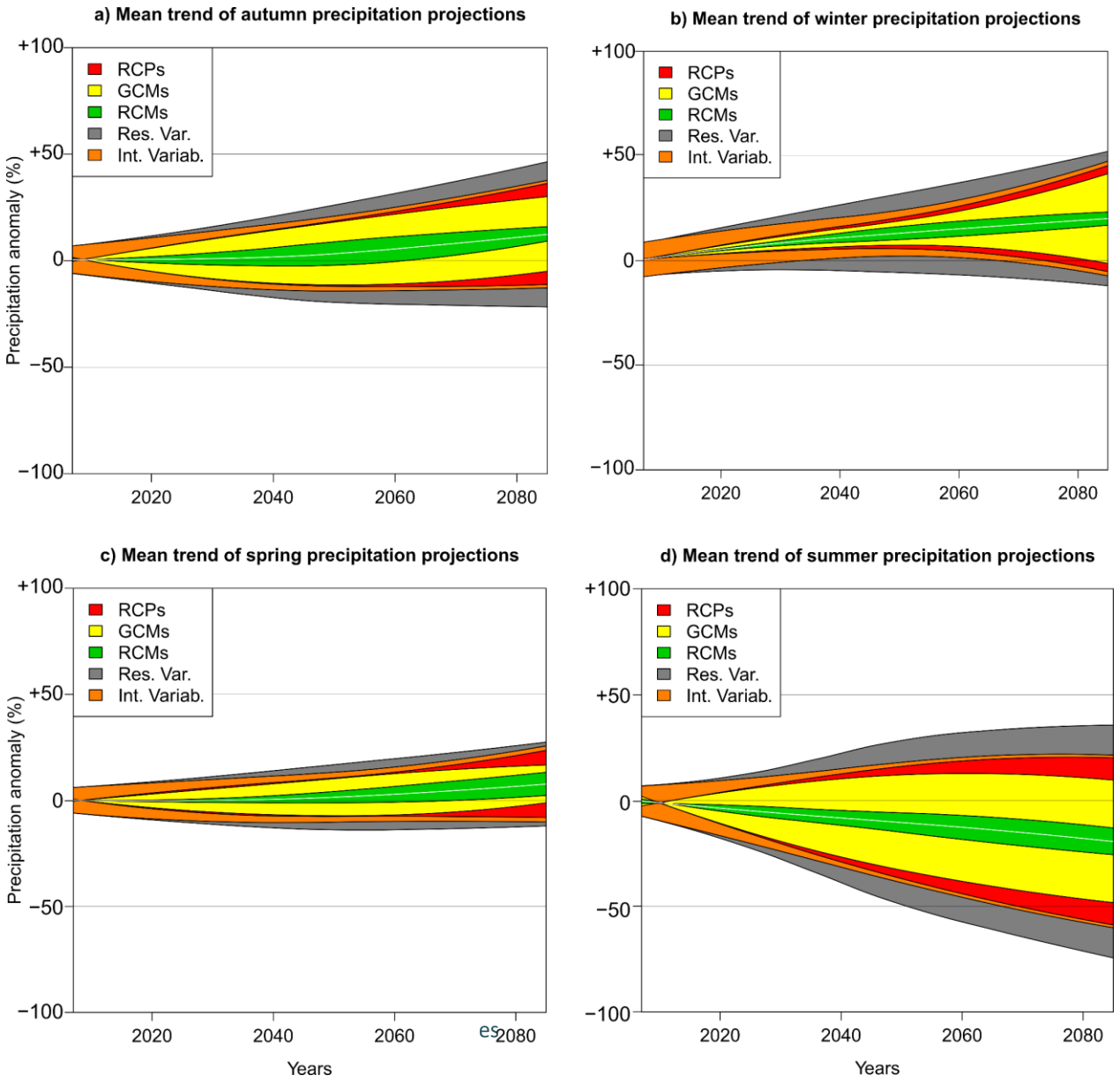




GR5J GRSD TUW

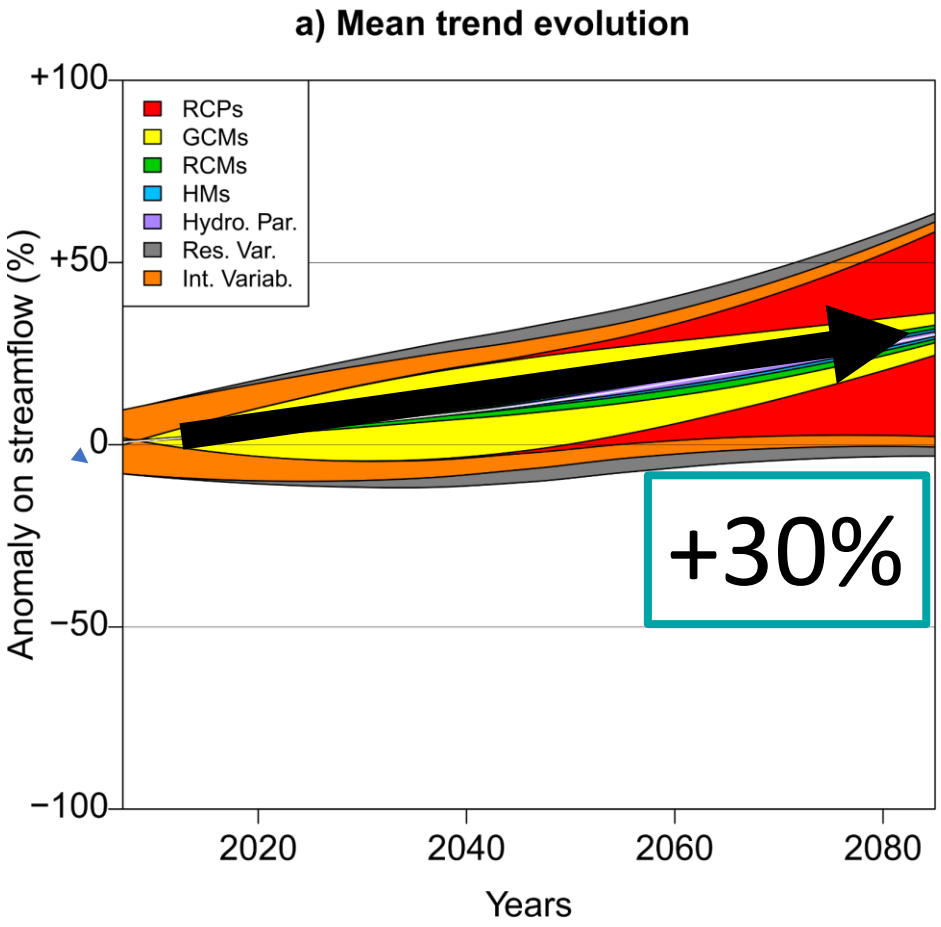
Future seasonal precipitation projections

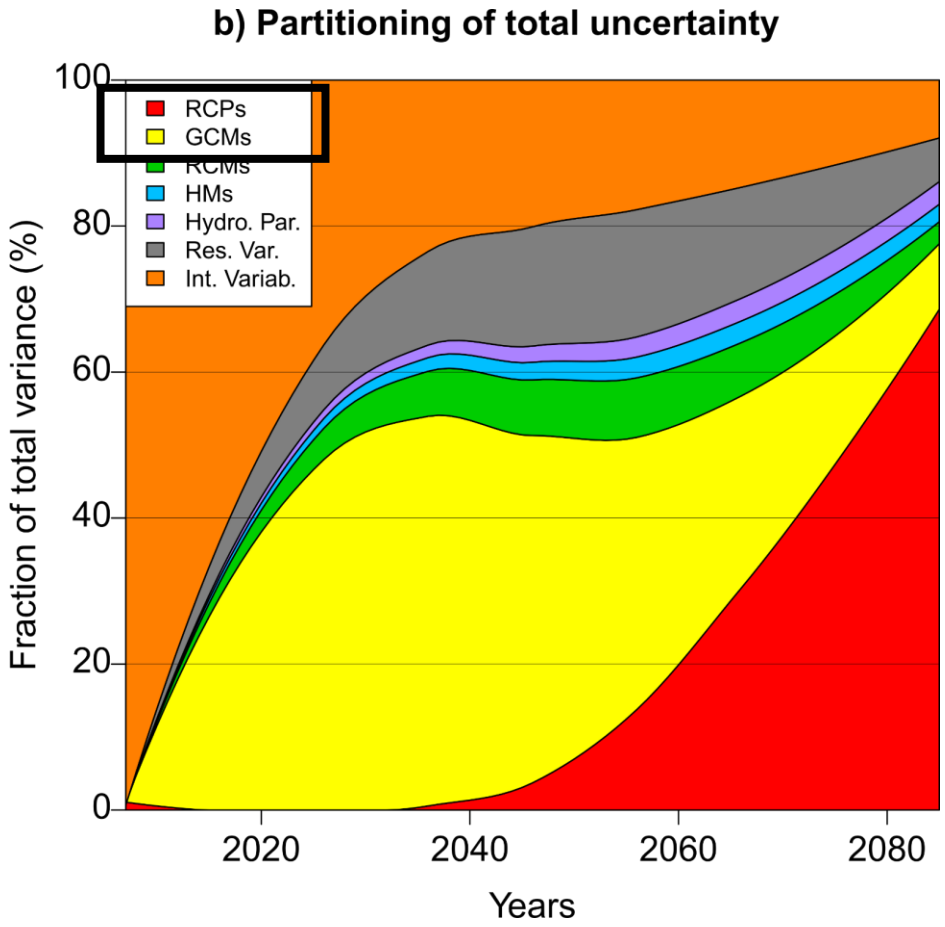
Res. Var.: Residual Variability
Int. Variab.: Internal Variability



Future hydrological extremes and uncertainty

Changes in extreme high-flows:

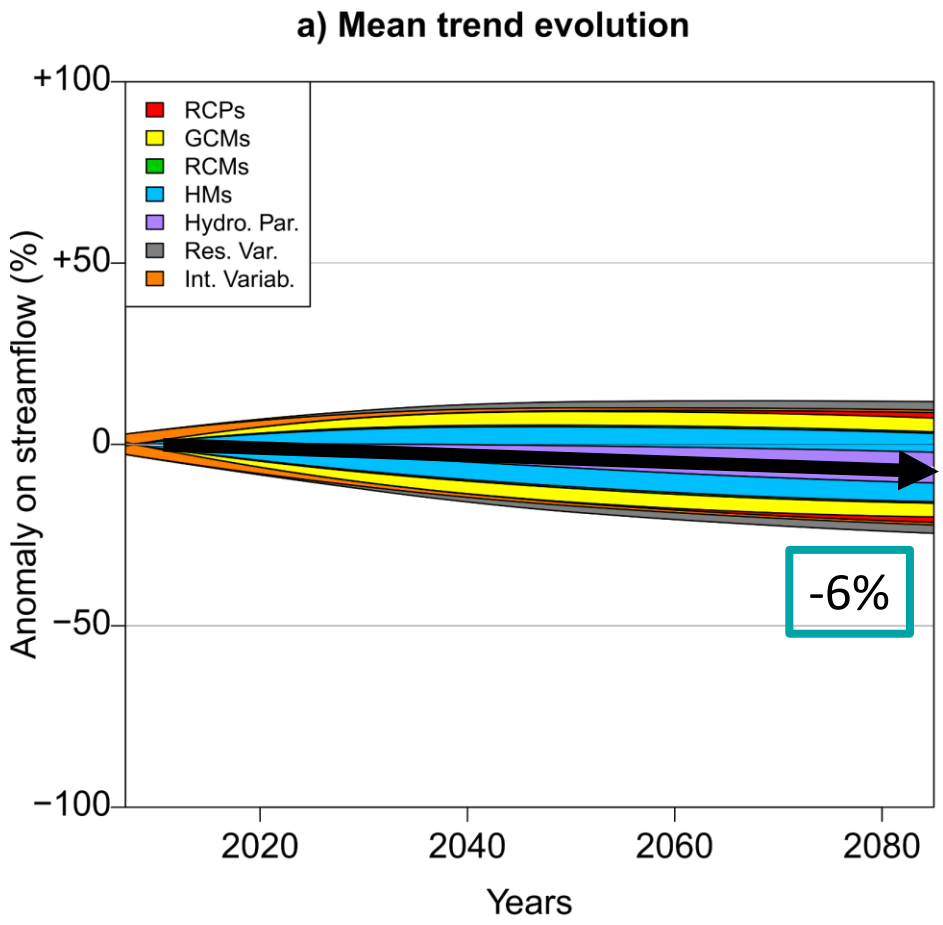


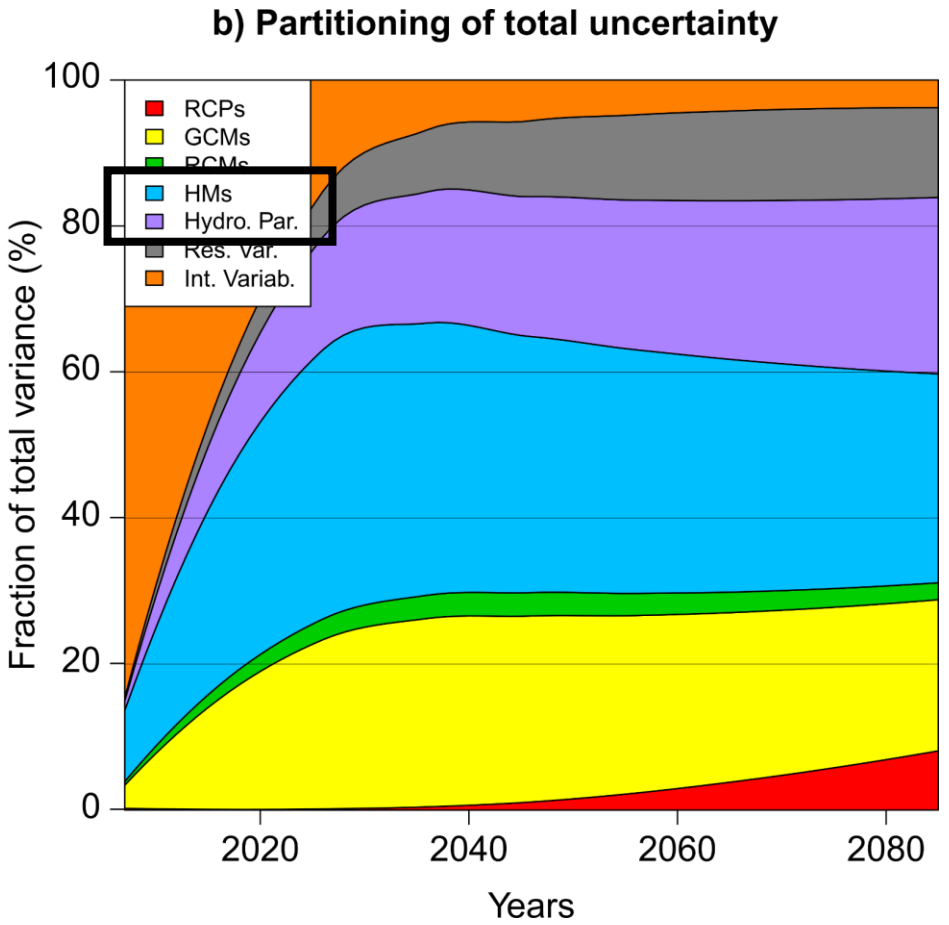


Main uncertainty sources: RCPs and GCMs

Future hydrological extremes and uncertainty

Changes in extreme low-flows:

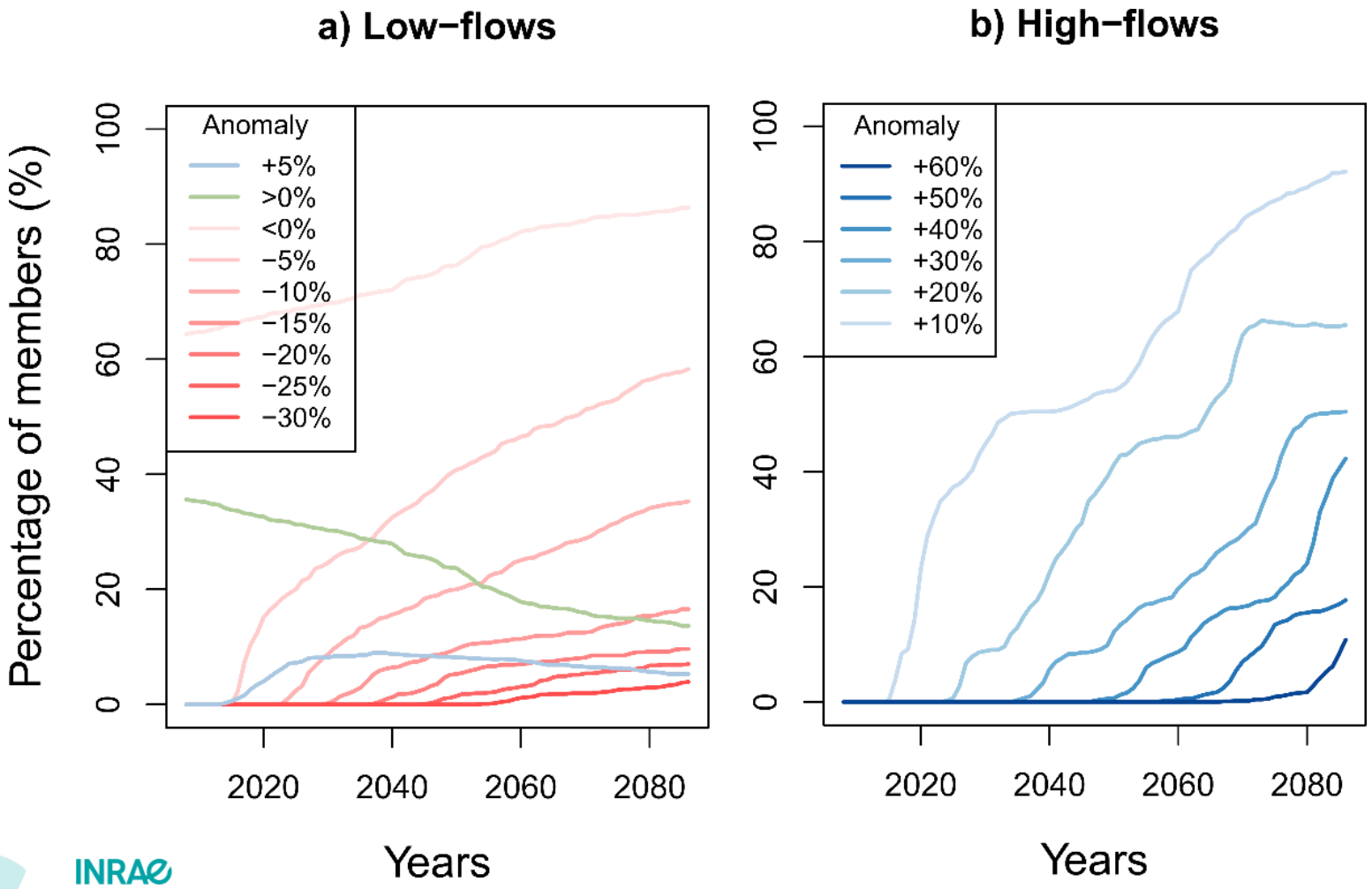




Main uncertainty sources: Hydrological model structure and parameters

Trend agreement across ensemble members

To which degree the ensemble members agree for each future change?



Discussion

What constrains hydrological extreme projections?

Hydrological projections depend strongly on:

1. Hydrological model selection
   → Models that are not adapted to local conditions induce more uncertainty to future projections

2. Seasonal precipitation projections
   → Extreme high-flows correlated to autumn and winter precipitations in Mediterranean catchments
   → Extreme low-flows correlated to summer precipitations (no clear trend for summer precipitations)

3. Climatic model selection
   → The 5 GCM/RCM couples belong to a « wet » sample compared to the whole EURO-CORDEX panel

→ Clear trends for high-flows, no clear trend for low-flows

Conclusions

So.. What can in say now?

It depends!

<u>Based on our data and model selection</u>:

Changes to 2080:

It is likely that high-flows increase by 30%

There is no clear trend for low-flows

Main sources of uncertainty:

RCPs and GCMs for high-flows

Hydrological model structure and parametrization for low-flows

Thanks! Questions? Let's chat!

Contact us:

lila.collet@inrae.fr

thibault.lemaitre-basset@inrae.fr

Have a look soon at our publication:

Lemaitre-Basset, T., Collet, L., Thirel, G., Parajka, J., Evin, G., Hingray, B. (in review) Climate change impact and uncertainty analysis on hydrological extremes in a Mediterranean catchment. *Hydrological Sciences Journal*