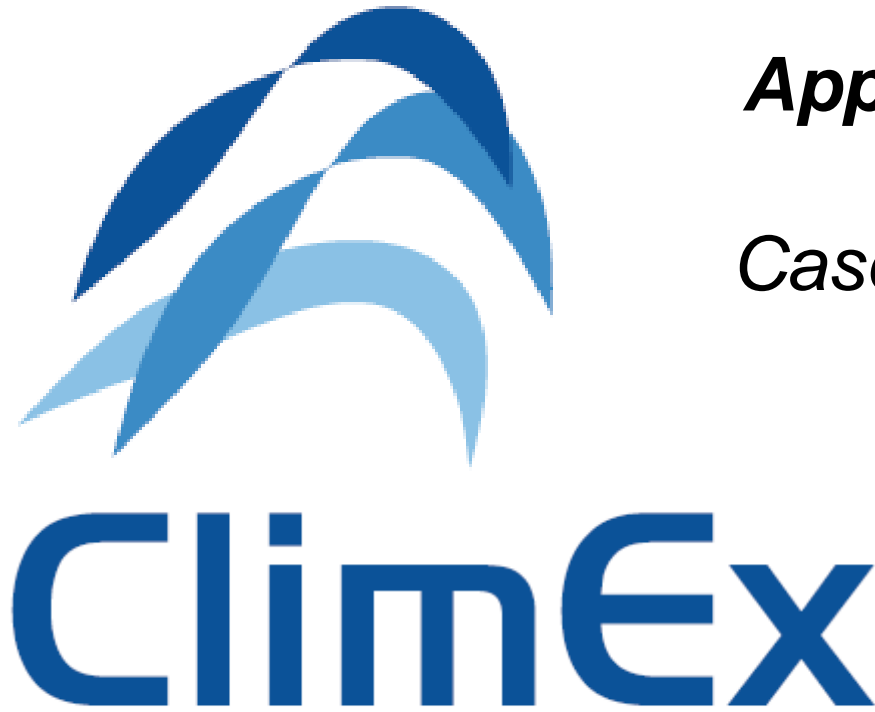


Application of ClimEx data for flood analysis

Case study of the Richelieu river



Presentation by Simon Lachance-Cloutier
Philippe Lucas-Picher, Richard Arsenault, Annie
Poulin, Simon Ricard, Richard Turcotte



Bavarian Environment
Agency



INRS
UNIVERSITÉ DE RECHERCHE



**International Lake Champlain
and Richelieu River Study**

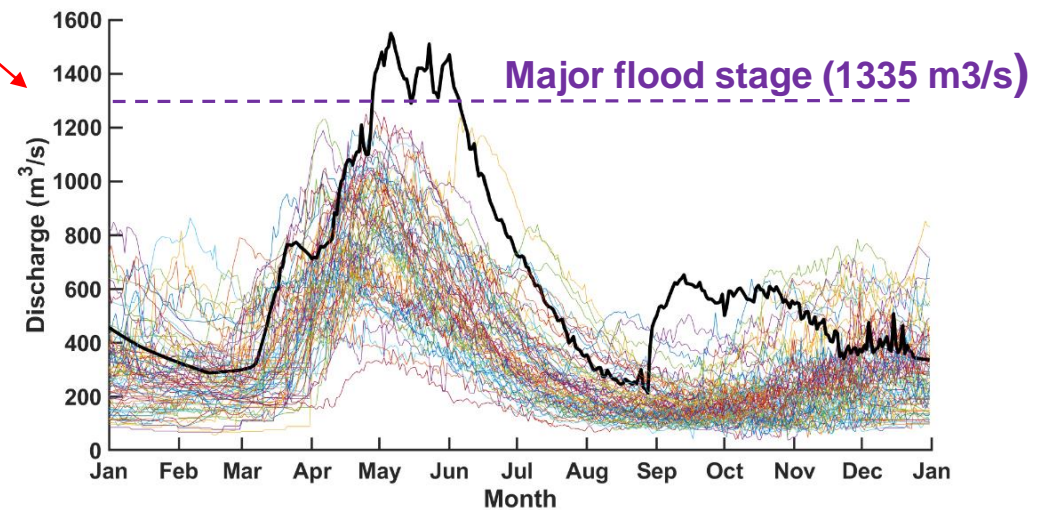
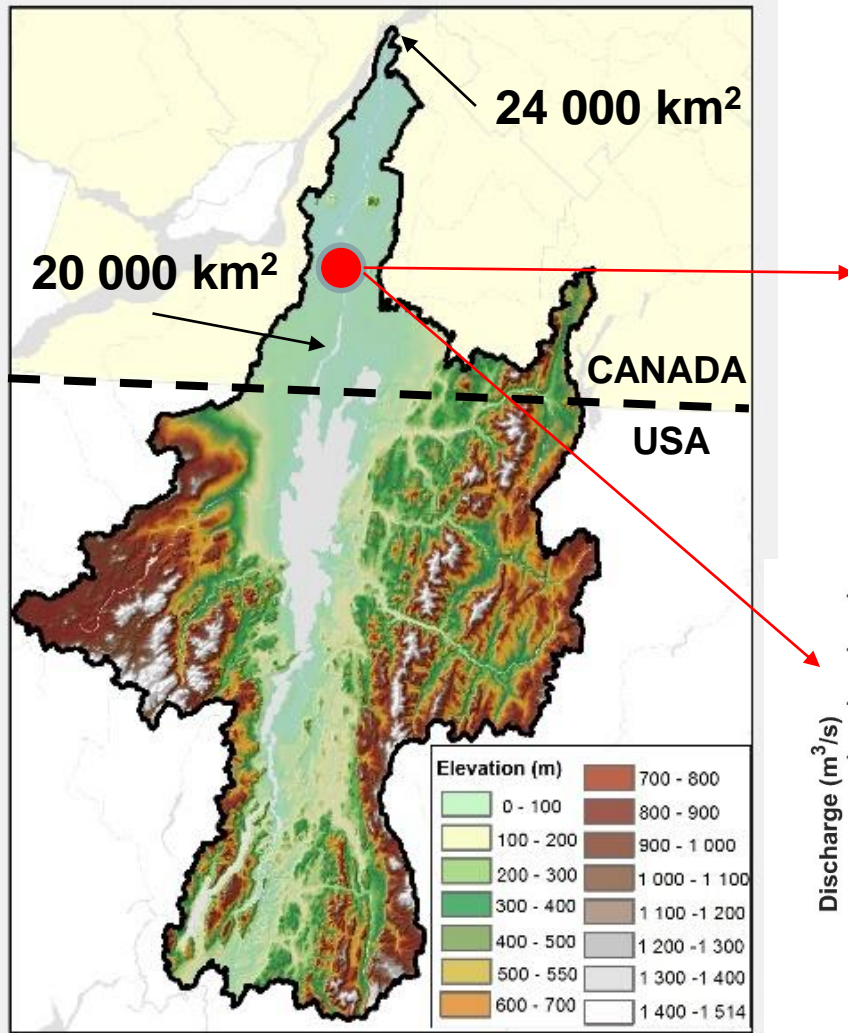
Hydrology, Hydraulics and
Mapping technical working group

Centre d'expertise
hydrique
Québec

lrz Leibniz-Rechenzentrum
der Bayerischen Akademie der Wissenschaften

gefördert durch
Bayerisches Staatsministerium für
Umwelt und Verbraucherschutz



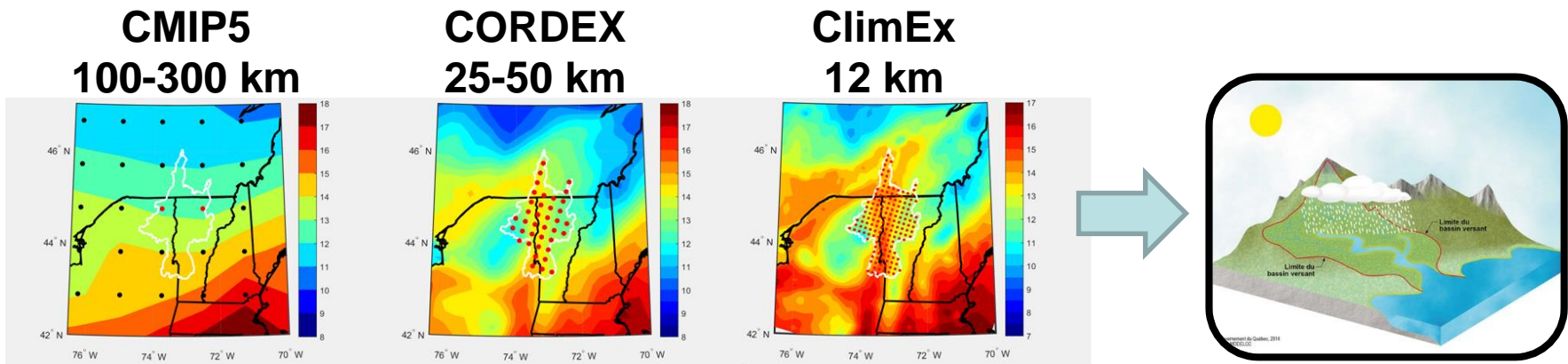




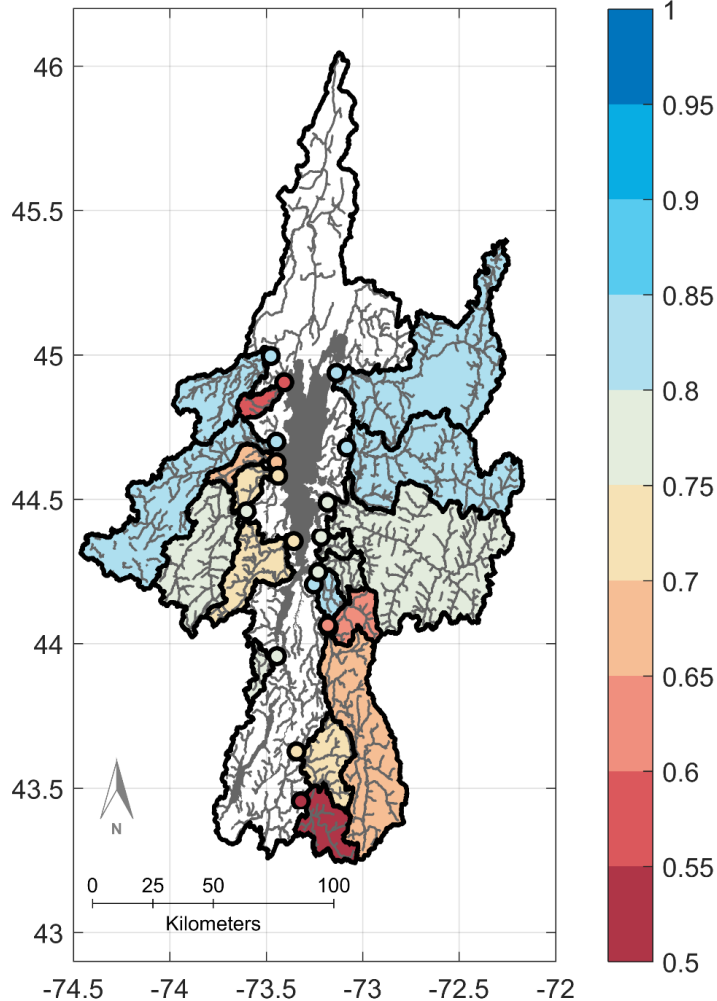
- Evaluate different flood mitigation measures in a context of changing climate.
- Produce net basin supply (NBS) scenarios for lake Champlain to feed an hydraulic model of the Richelieu river.

Proposed methodology

- Force an hydrological model with bias-corrected climate simulations



KGE in validation (2004-2013)



Hydrological model : Hydrotel

- Semi-distributed model (~8000 sub-units ; 3163 river stretches ; 45 lakes)
- Account for physiographic data
 - Soil texture
 - Land use
 - Elevation
- River routing & simple lake model
- Simple evapotranspiration formula

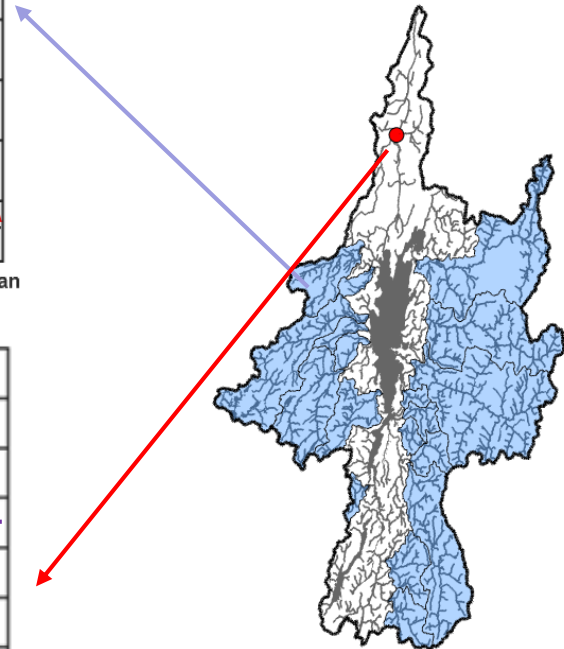
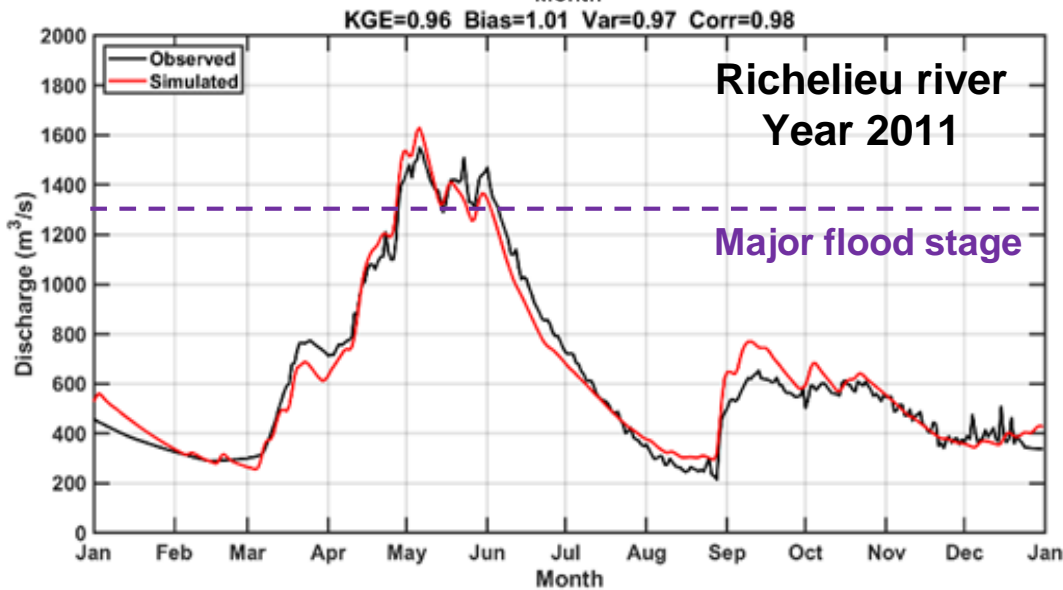
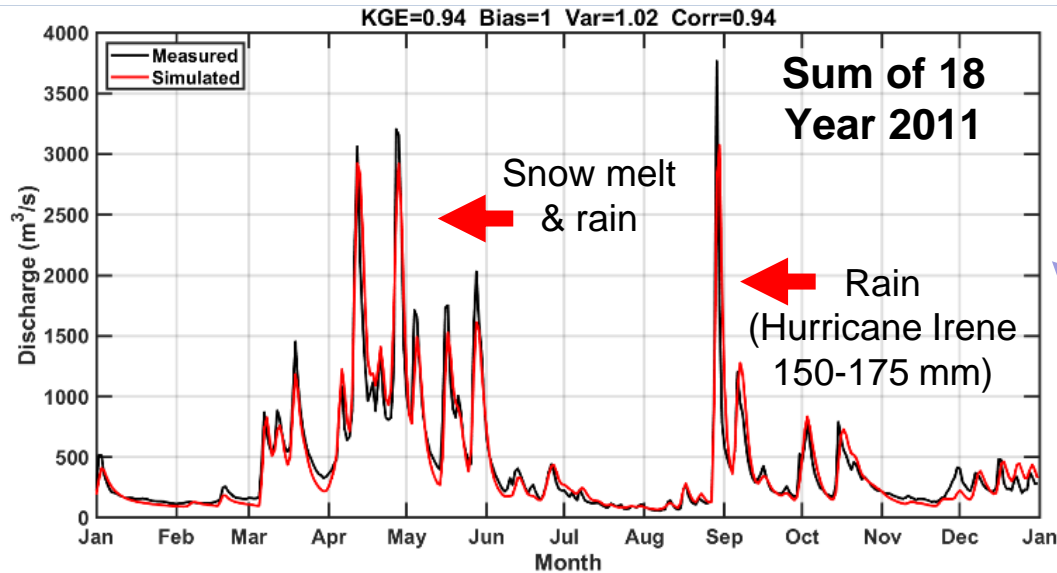
Model calibration

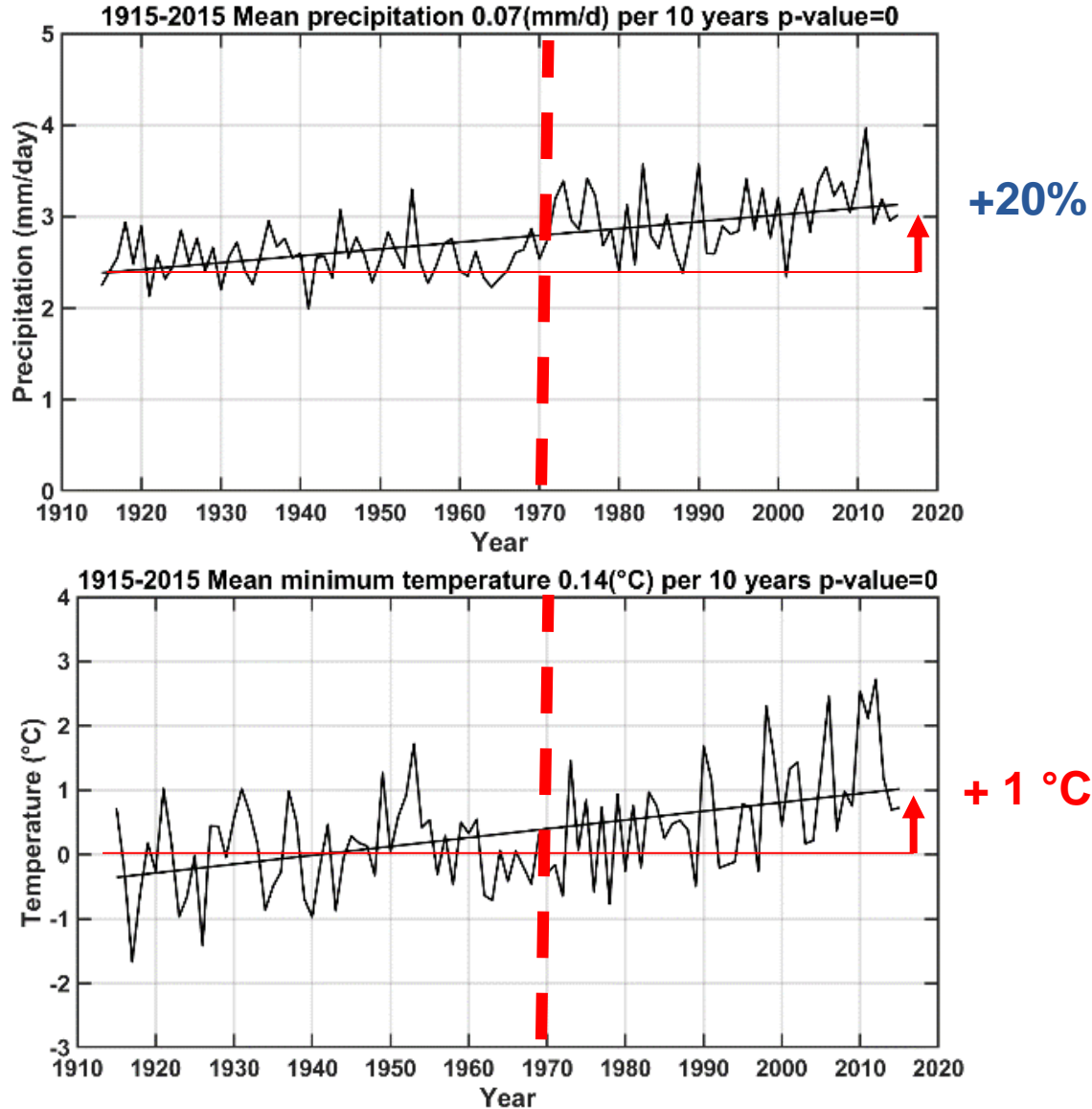
- Daily time step
- 10 «free» parameters
- Global calibration for 18 tributaries

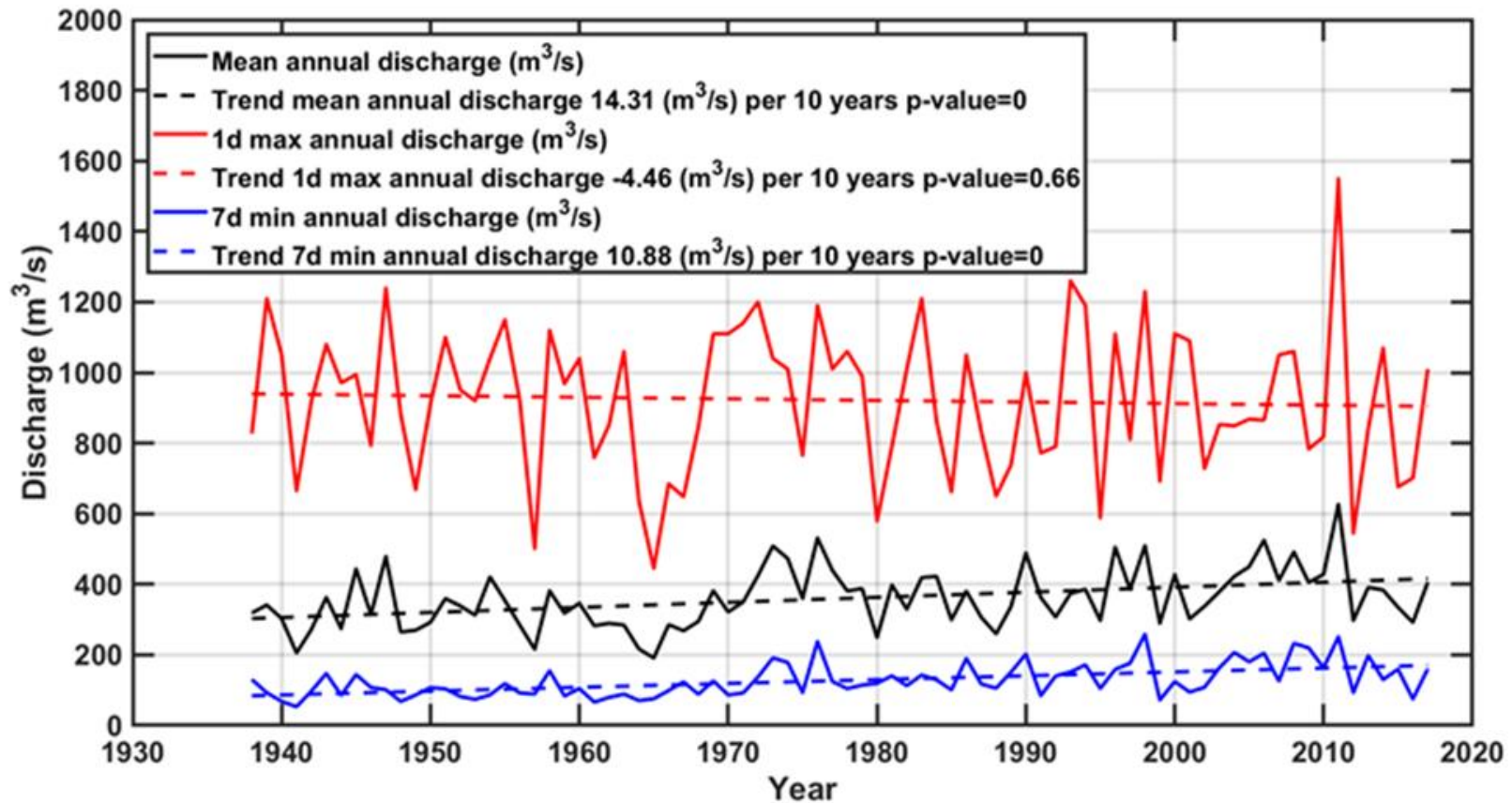
Calibration 1992-2003 : 0.75 KGE

Validation 2004-2013 : **0.73** KGE

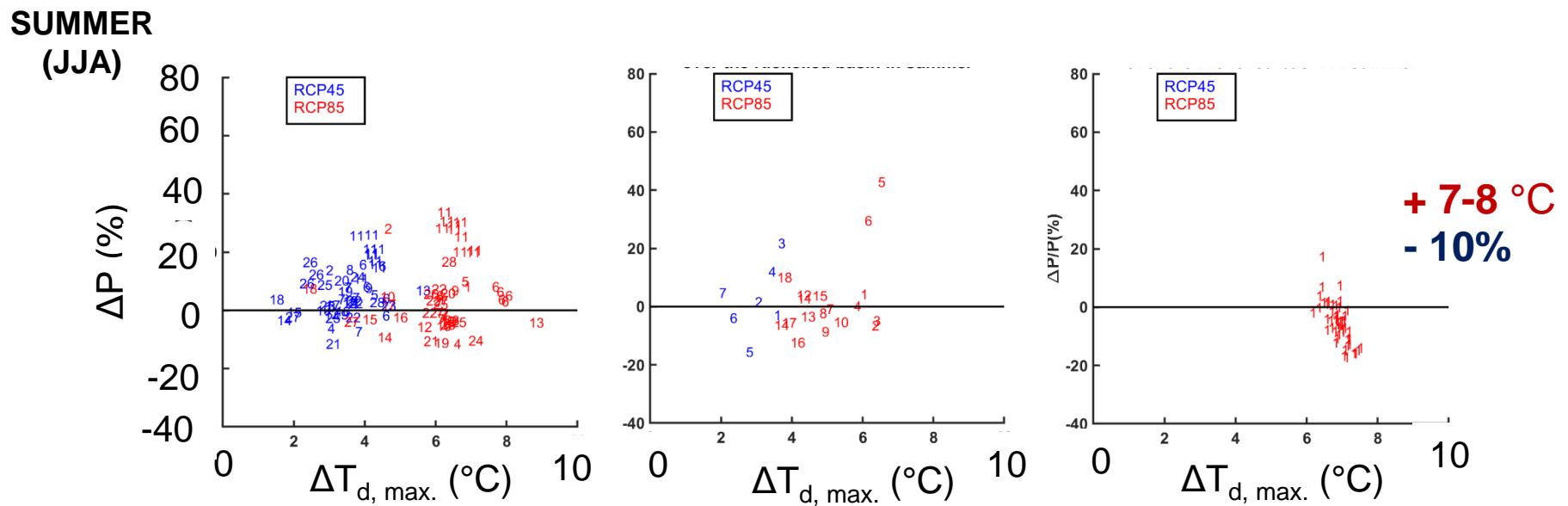
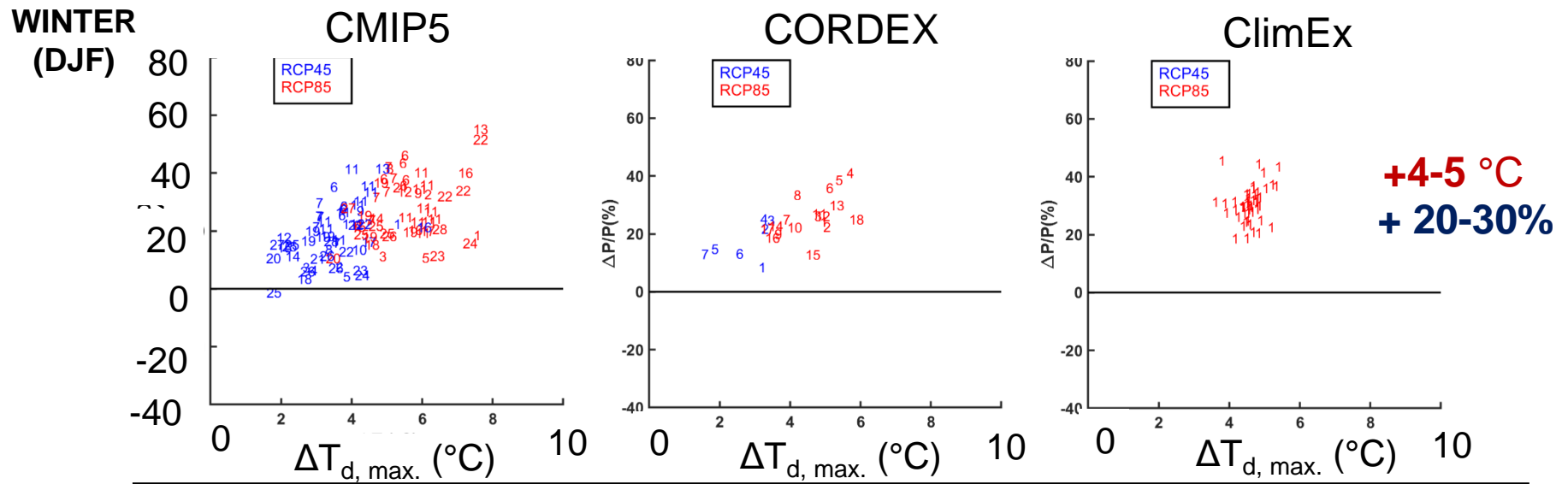
Validation of the hydrological model



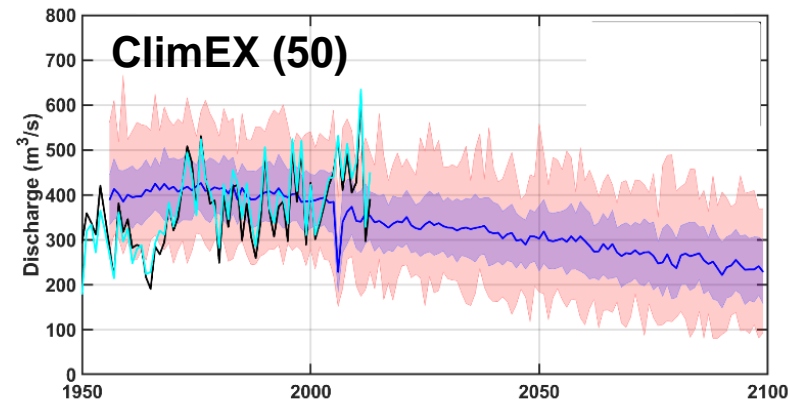
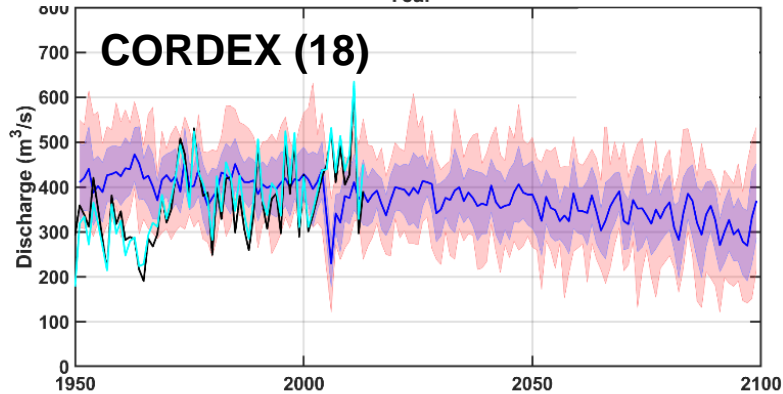
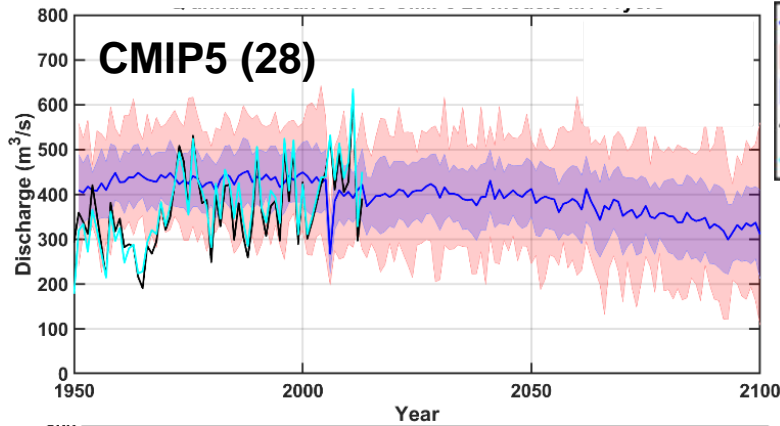




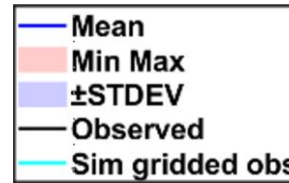
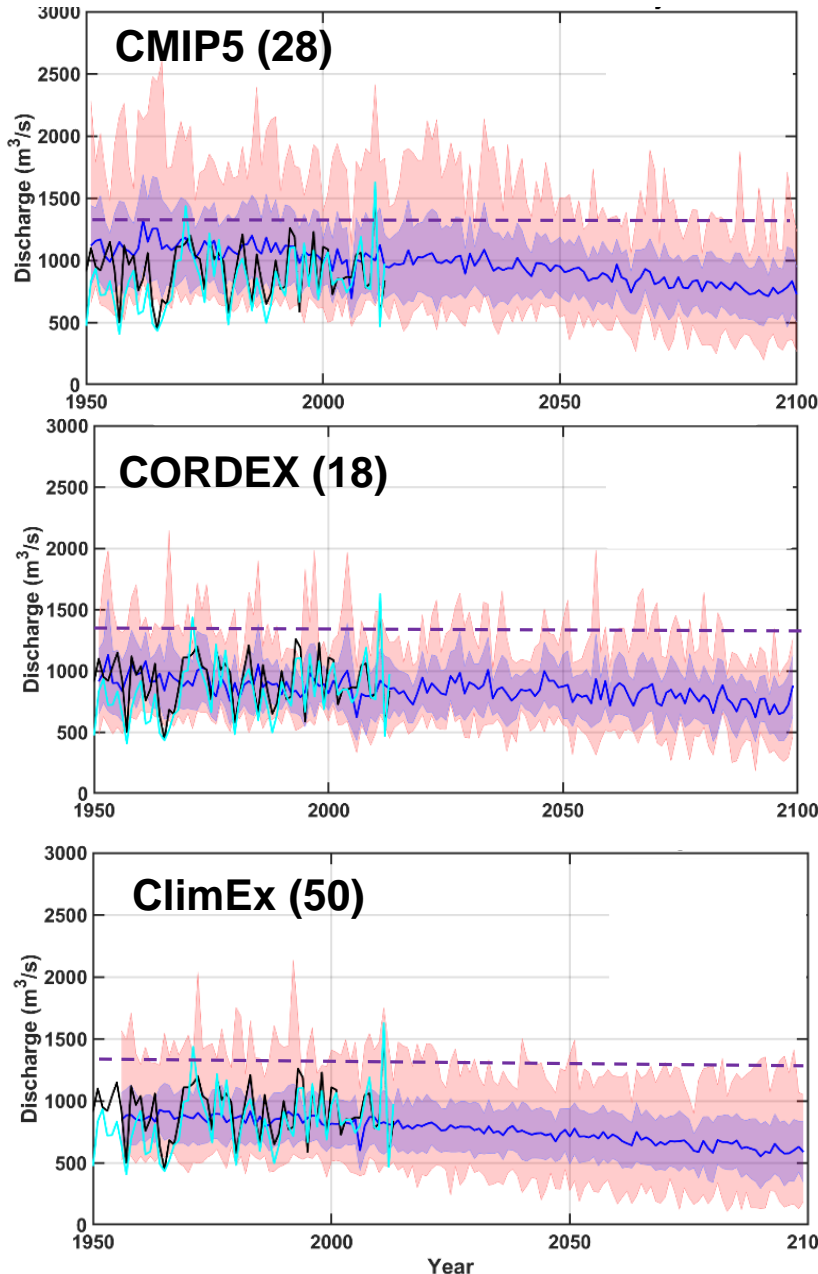
Expected change in climate 2070-2099



Annual mean flow of the Richelieu river : RCP8.5

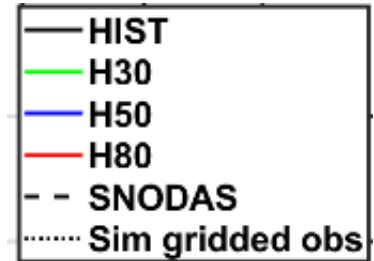
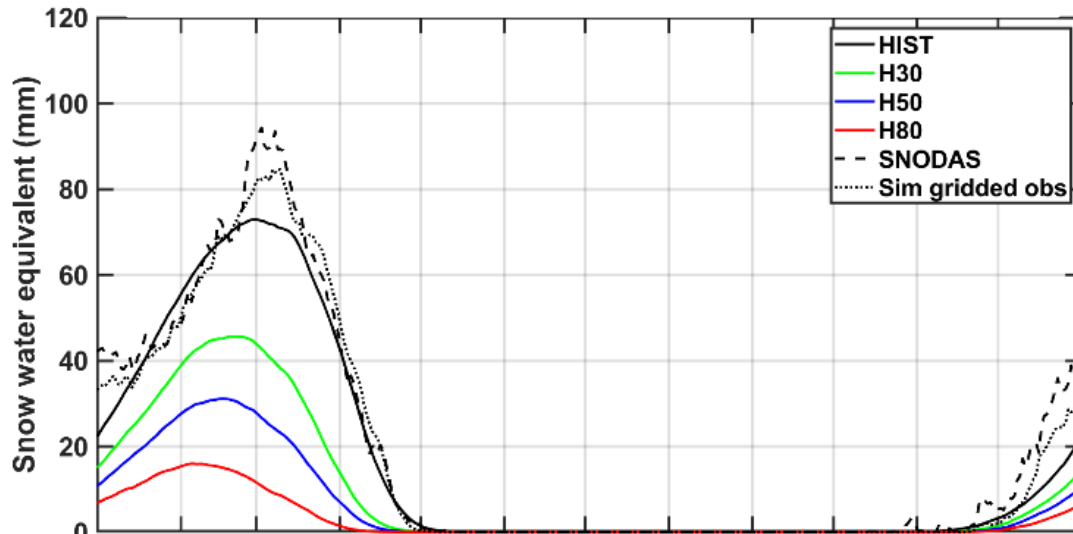


	1970-1999	2070-2099	Δ
P [mm] (Climate model)	1073	1172	+ 99
ET [mm] (Hydrological model)	453	683	+ 230
P [mm] (Climate model)	1077	1168	+ 91
ET [mm] (Hydrological model)	489	697	+ 208
P [mm] (Climate model)	1073	1091	+ 18
ET [mm] (Hydrological model)	478	715	+ 237

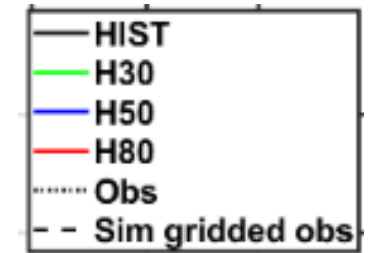
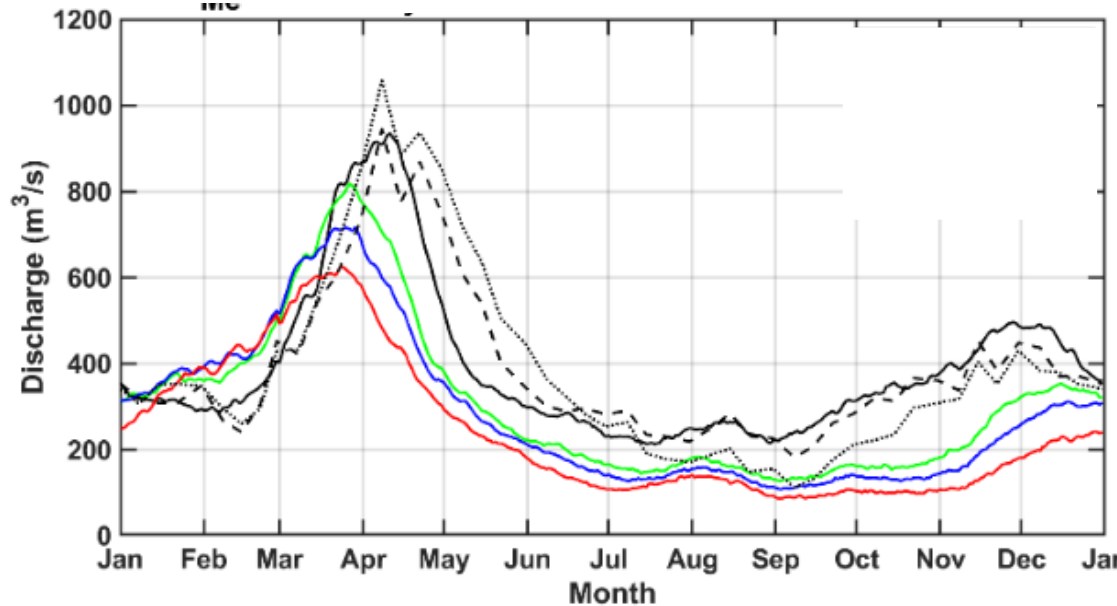


- Annual maximum flow simulated with CMIP5 are quite high
- Decreasing trend for all ensembles
- Major flooding might still happen in the future

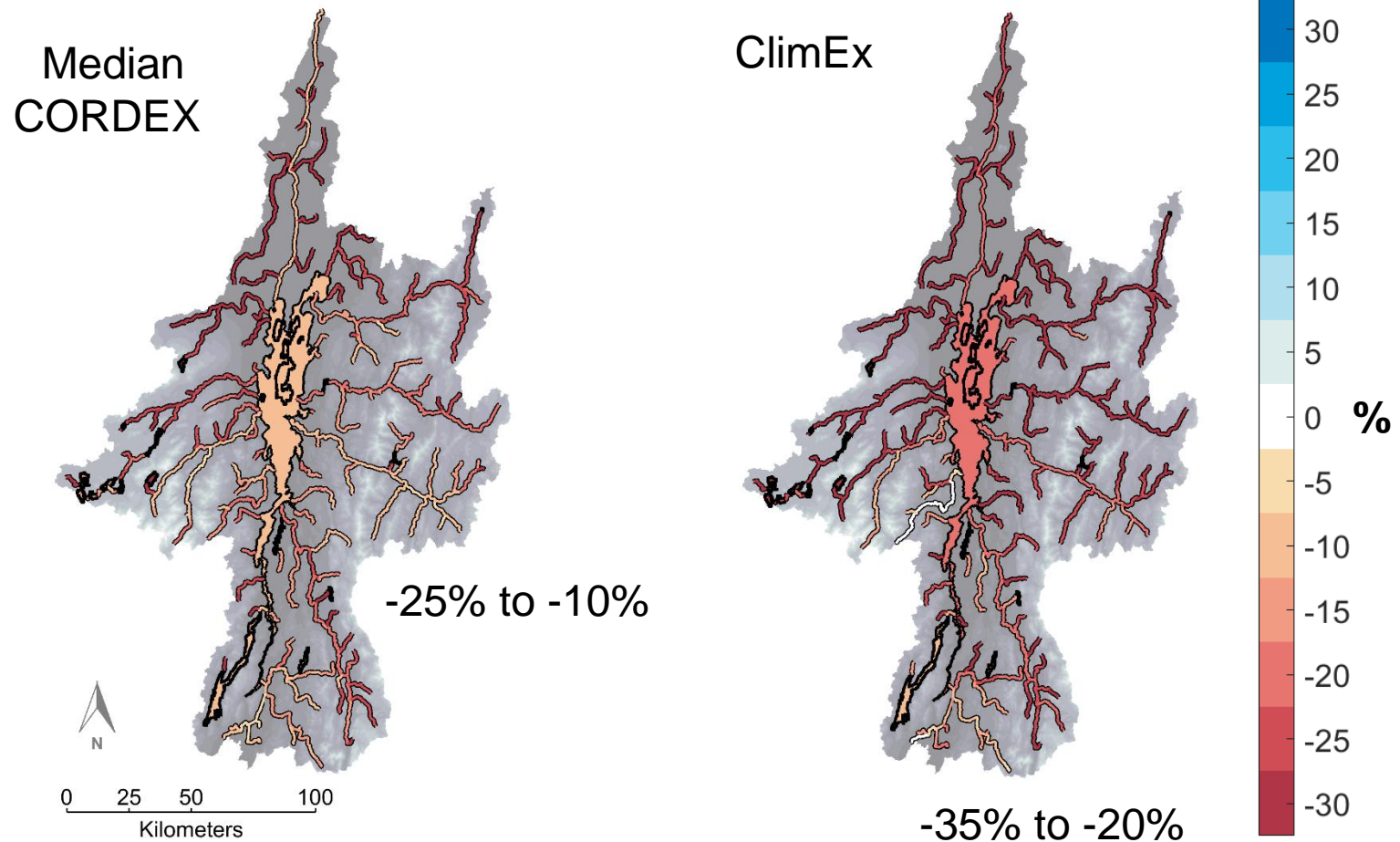
Snow water equivalent [mm]



Discharge [m³/s]



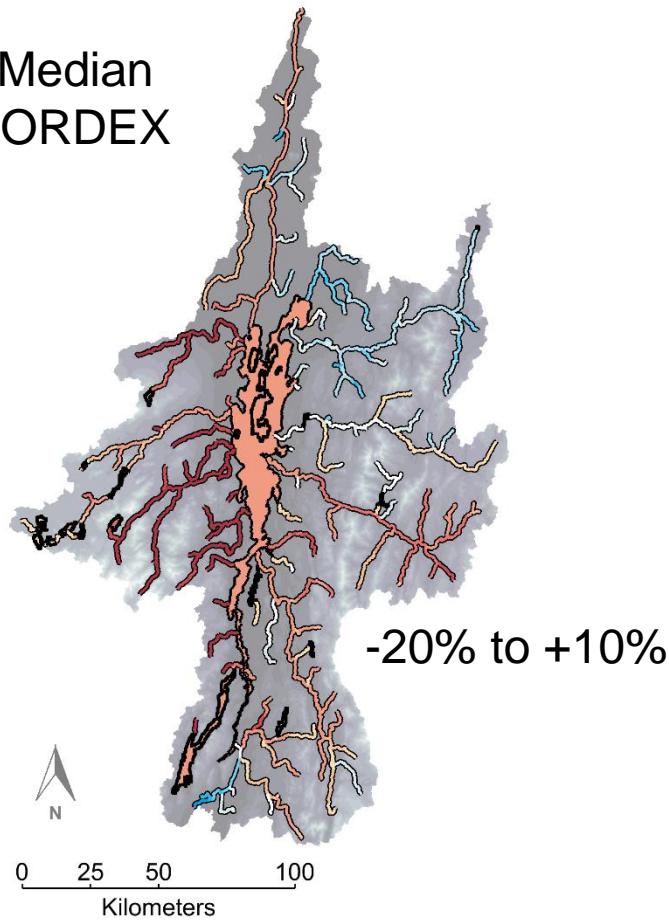
Relative change [%] : 2070-2099 v.s. 1970-1999
20-year return period **annual** maximum flow



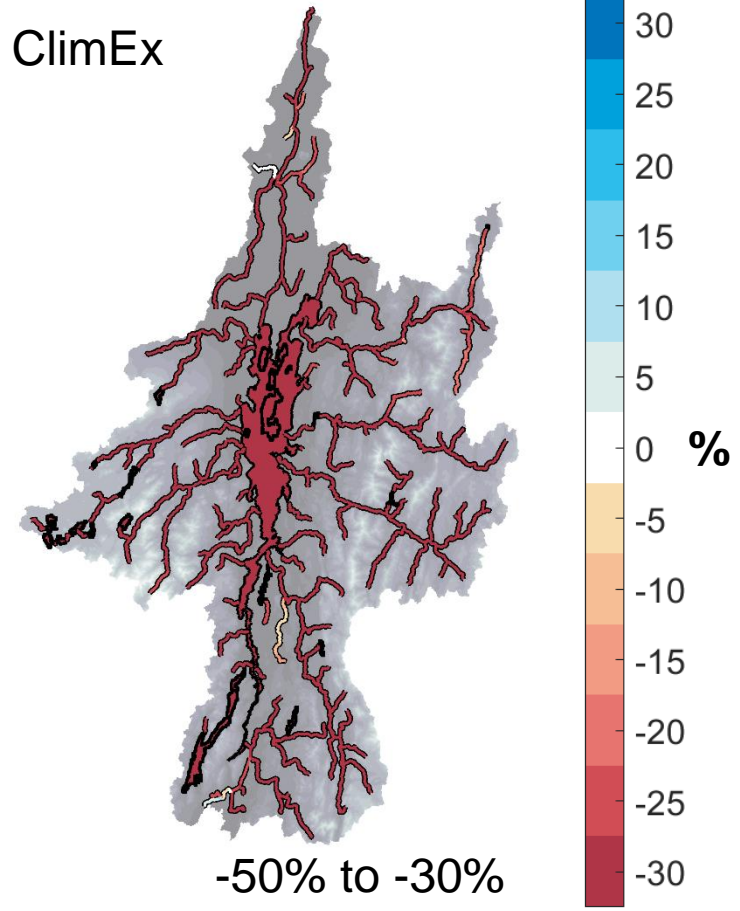
Drainage area > 50 km²

Relative change [%] : 2070-2099 v.s. 1970-1999
20-year return period **summer and fall** maximum flow

Median
CORDEX



ClimEx



Drainage area > 50 km²

For the Richelieu river, all 3 climates ensembles points towards :

- A. A reduction of annual mean flow
- B. A reduction of annual maximum flow

Limitations

- Single impact model & PET formula
- Model performance in «dry» condition

References

Lucas-Picher, P., Arsenault, R., Poulin, A., Ricard, S., Lachance-Cloutier, S. & Turcotte, R. (2019). *Implementation of a high-resolution distributed hydrological model over the Richelieu basin: Ability to reproduce the mean annual cycle and the 2011 flood*. Manuscript submitted for publication.

Lucas-Picher, P., Arsenault, R., Poulin, A., Ricard, S., Lachance-Cloutier, S., Turcotte, R. & Brissette, F. *Will climate change worsen Richelieu River flooding?* Unpublished manuscript.