

The cQ2 collaboration : a task force for improved assessment of climate change impacts on hydrology and hydropower in Québec



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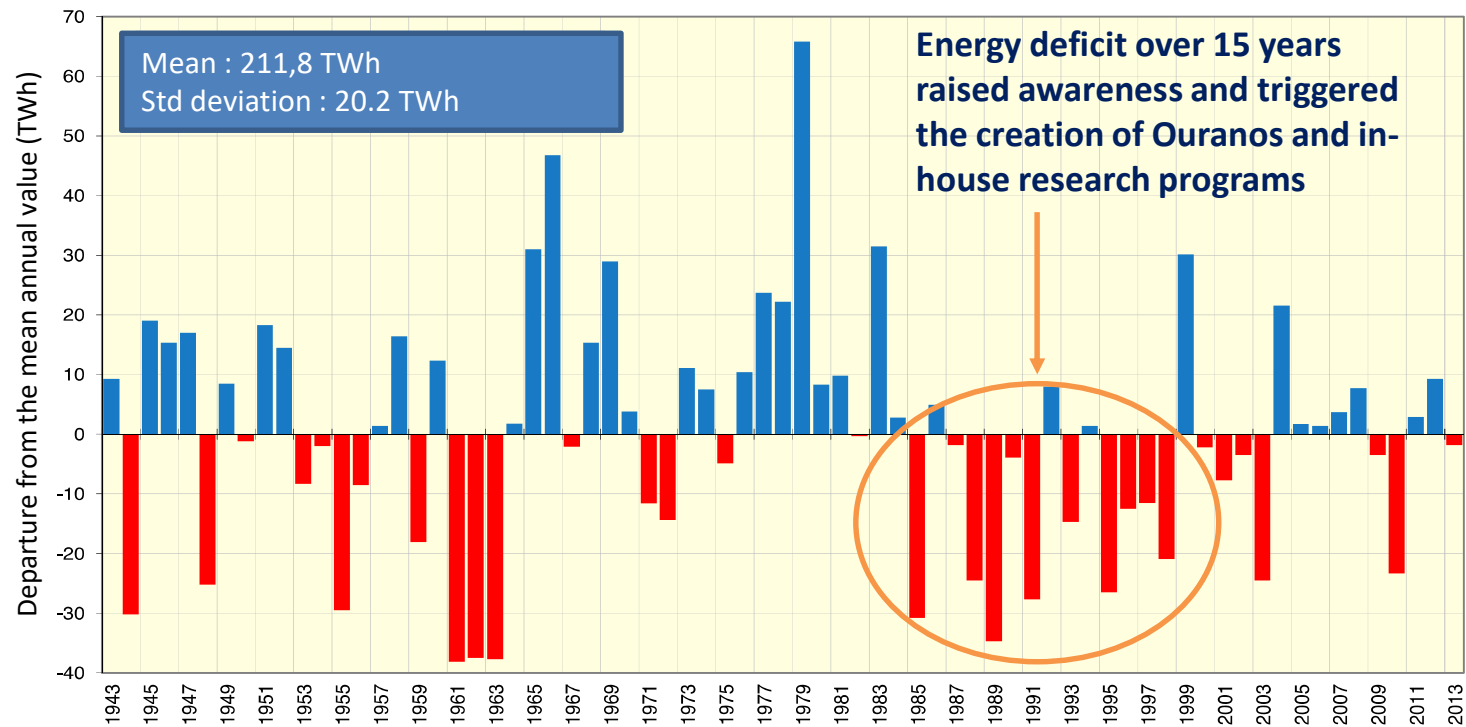
PLAN

- Generating hydropower under a changing climate : the hydrological angle
- The cQ2 collaboration
 - Description and objectives
 - The study area
 - The modeling cascade
 - Some results

GENERATING HYDROPOWER UNDER A CHANGING CLIMATE



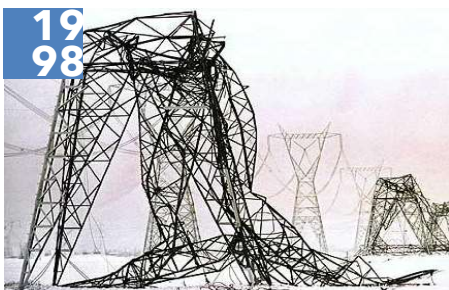
GENERATING HYDROPOWER UNDER A CHANGING CLIMATE



GENERATING HYDROPOWER UNDER A CHANGING CLIMATE

MAJOR ICE STORM

25 deaths
Over 1K electrical pylons
and 35K wooden utility
poles collapsed
4M people without
electricity



19
98

20
18

EXCEPTIONAL SPILLS

Spilling from July
20th to August
22nd
(2.56 TWh)



HISTORIC FLOOD IN SAGUENAY

10 deaths
> 1700 houses and
900 cottages
destroyed
dams and dykes
damaged



19
96

FLOOD IN SOUTHERN QUÉBEC

4k people evacuated
261 townships impacted
5371 flooded houses
557 damaged roads



20
17

FLOOD IN SOUTHERN QUÉBEC

12k people evacuated
310 townships impacted
9070 flooded houses
760 damaged roads



20
19

THE cQ2 COLLABORATION



cQ2 | DESCRIPTION AND OBJECTIVES

> Four (4) members :

- *Direction de l'Expertise Hydrique* (DEH, gov. agency)
- Hydro-Québec
- Ouranos
- Rio Tinto Alcan (Aluminium producer)

> Objectives :

- **Share and identify best practices in hydrological impact studies**
 - Understand the impact of different modelling choices such as bias correction methods and hydrological models
- **Deliver a concerted message about the impact of climate change on the hydrology in Québec**



Impact des changements climatiques sur
l'hydrologie au Québec

Climate change impacts on Québec hydrology

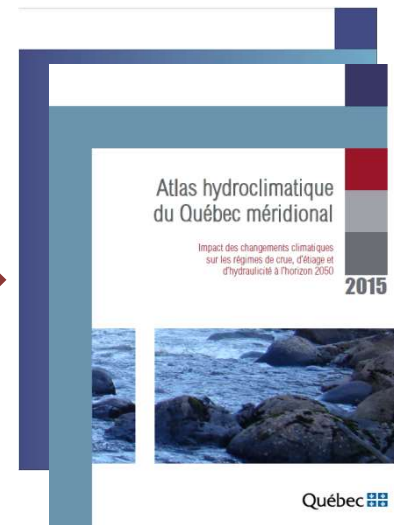
~2-3 Phases :

- 2012
- 2014
- 2018-2021...

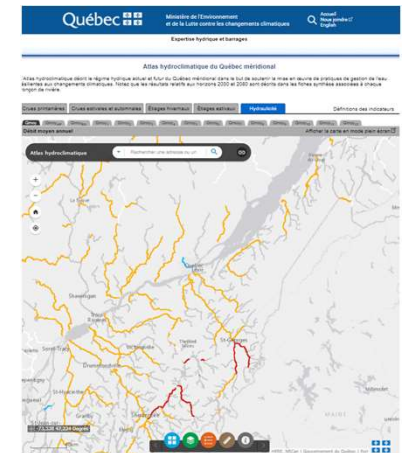
cQ2 | DESCRIPTION AND OBJECTIVES



The DEH (gov. agency) is focused on the populated area of Québec and publishes a publicly available hydroclimatic atlas.



Québec



cQ2 | STUDY AREA



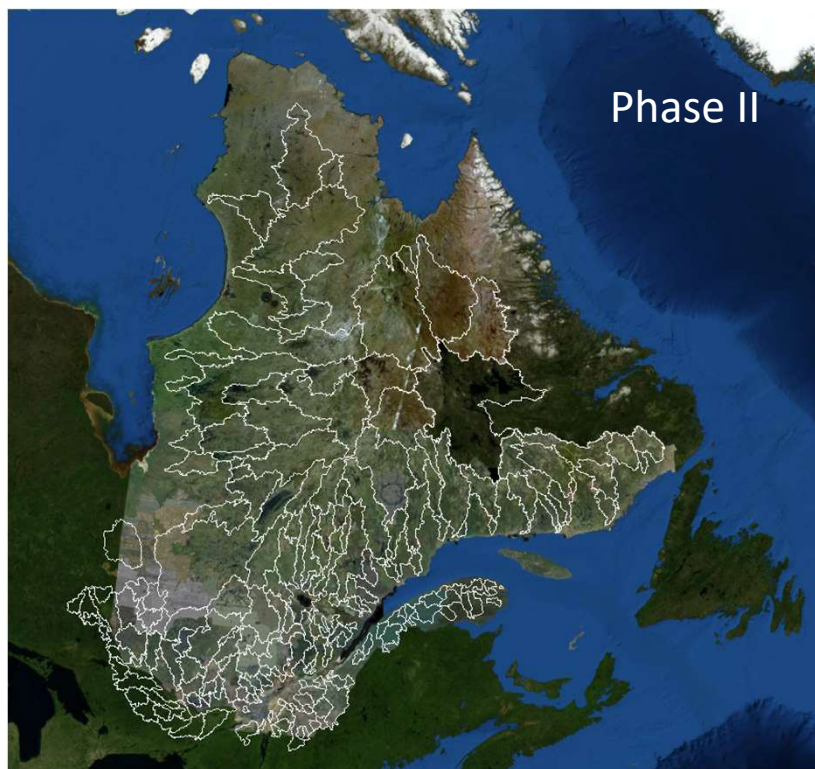
Hydro-Québec's modelling area

- ✓ 305 watersheds
 - 87 HQ hydrometric stations or dams
 - 202 DEH hydrometric stations
 - 17 Rio Tinto Alcan stations and dams

Data types

- ✓ Net basin supply
- ✓ River discharge

cQ2 | STUDY AREA



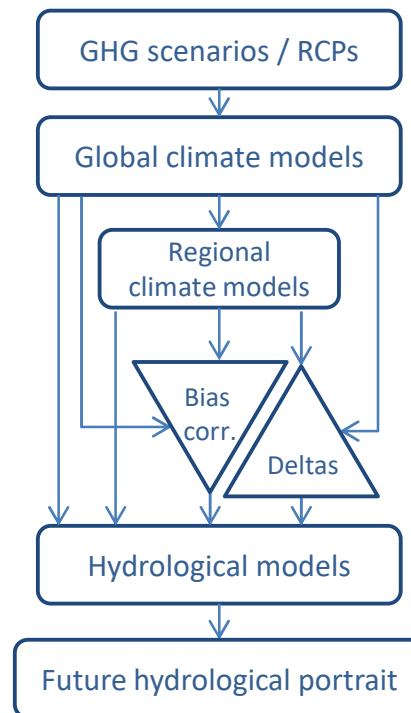
Phase II - 211 watersheds

- ✓ Removal of redundant watersheds
- ✓ Analysis of data quality for calibrating the hydrological model

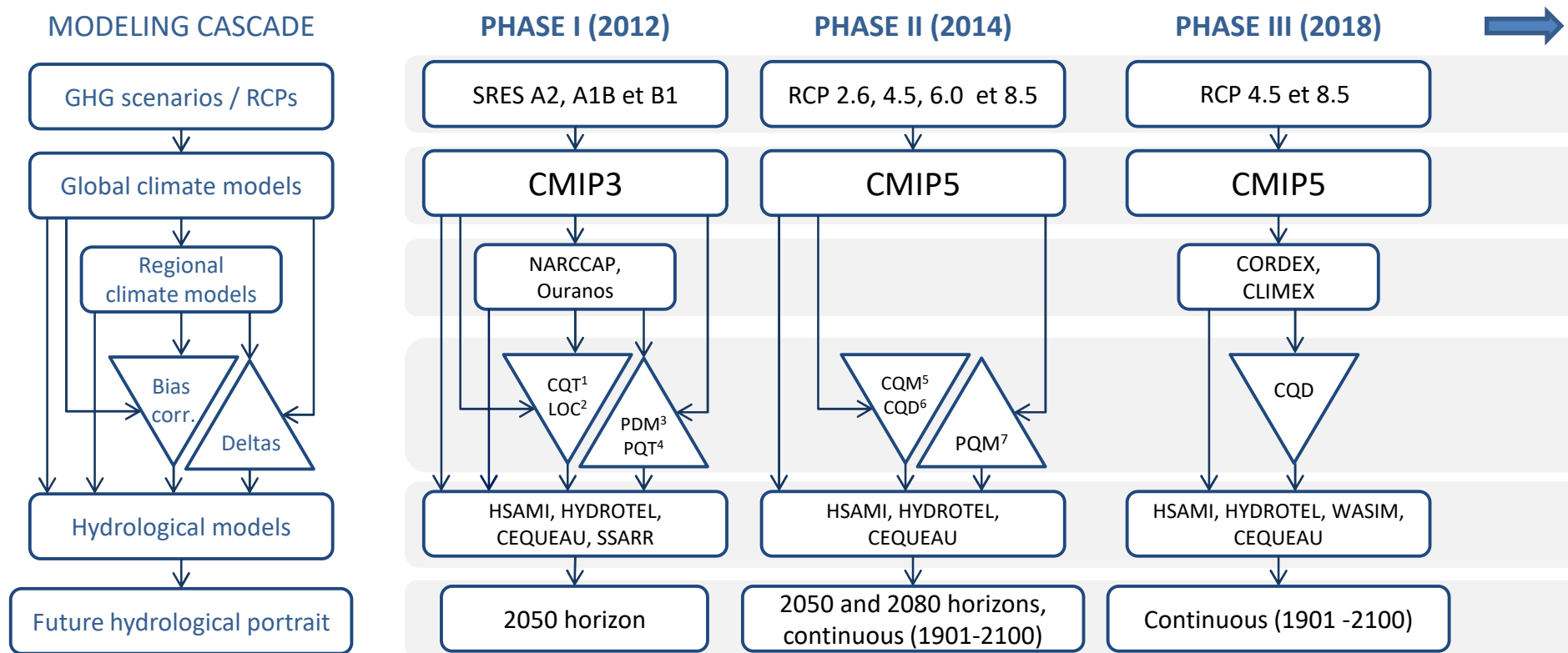
2021 ...

- ✓ 98 watersheds managed by Hydro-Québec
- ✓ Ongoing analysis of ~1.5k hydrometric stations from various datasets

cQ2 | MODELING CASCADE

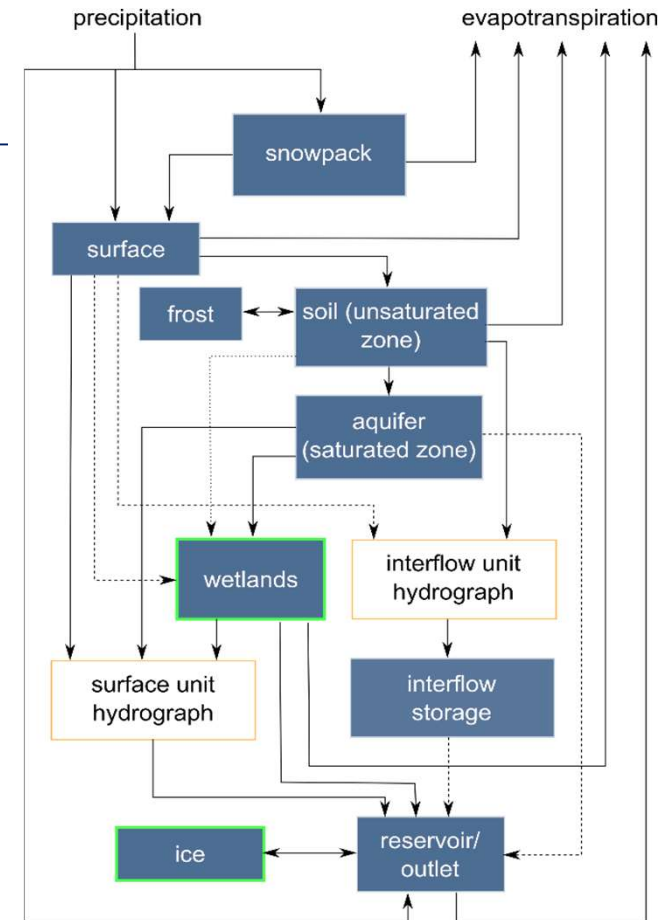


cQ2 | MODELING CASCADE

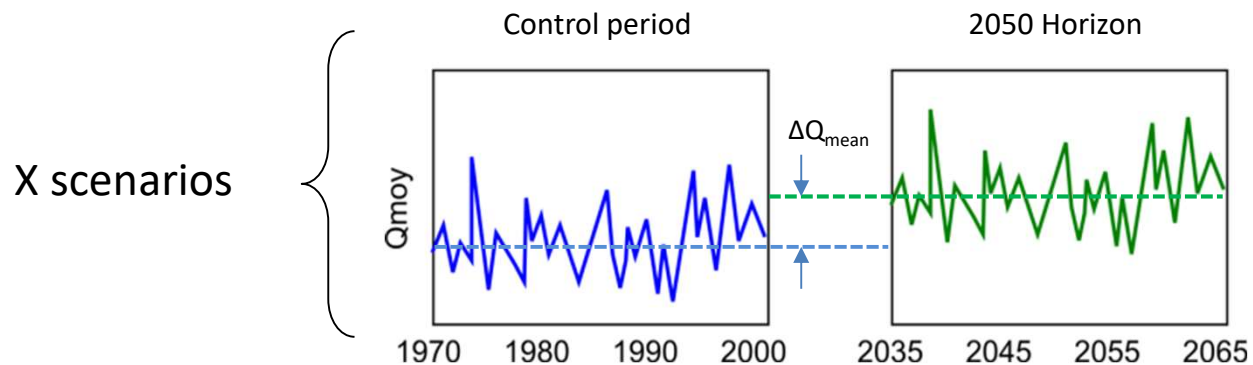


cQ2 | HSAMI MODEL

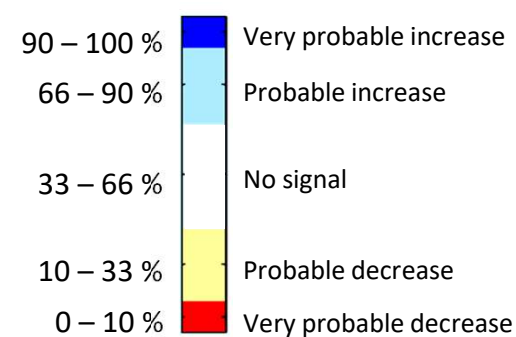
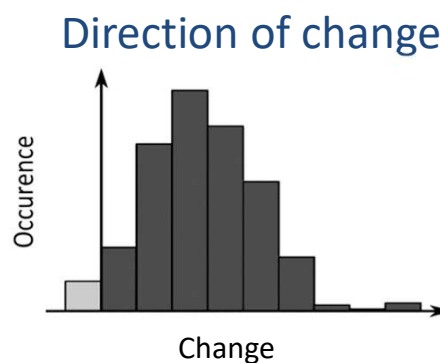
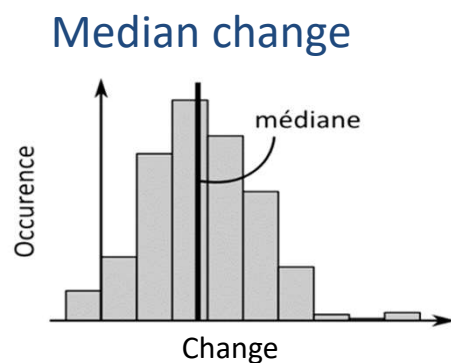
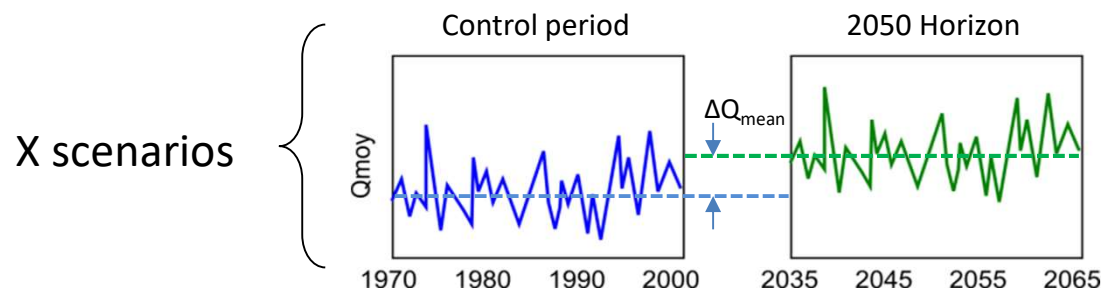
- Modular, lump and conceptual model used at Hydro-Québec since the 1980's for daily flow forecast
- Inputs : T_{\min} , T_{\max} , P , SWE (opt.) and multiple physiographic properties of the watershed
- Daily time step
- 50 calibration parameters
 - Calibration strategies specific to climate change impact studies (aim at robustness under a contrasted climate)



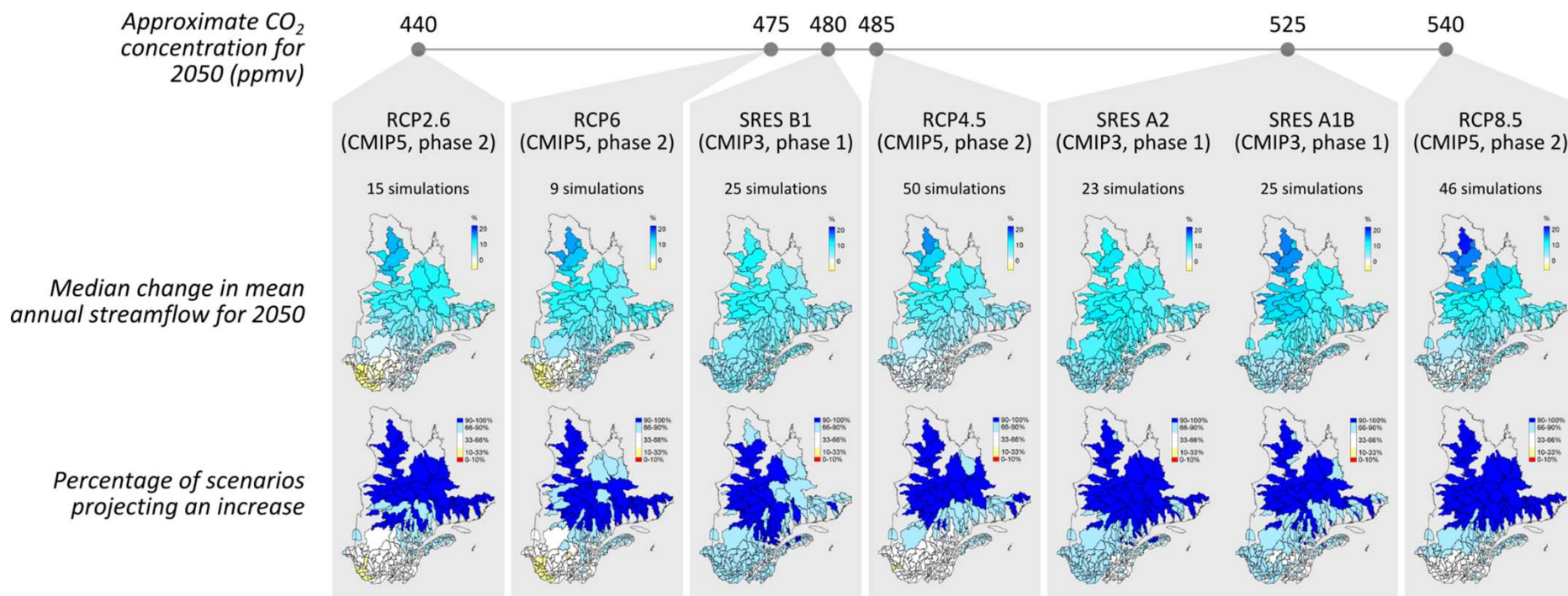
cQ2 | RESULTS



cQ2 | RESULTS



cQ2 | RESULTS

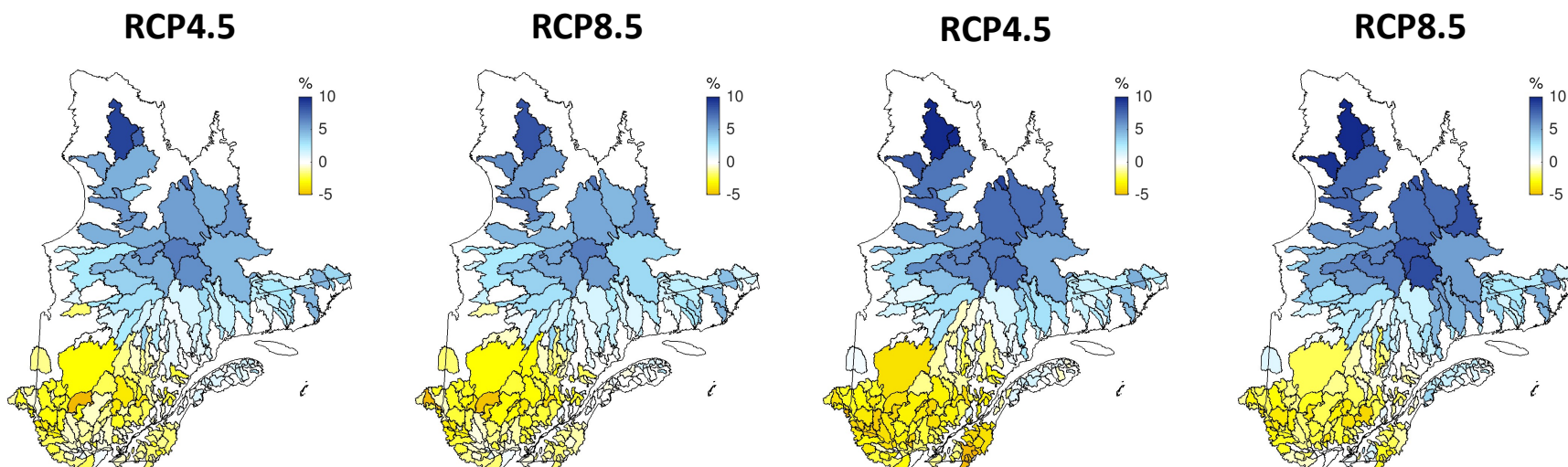


cQ2 | RESULTS

- Change in mean annual streamflow – CMIP5 ensemble, continuous simulations, quantile mapping with detrending, control period : 1991-2020.

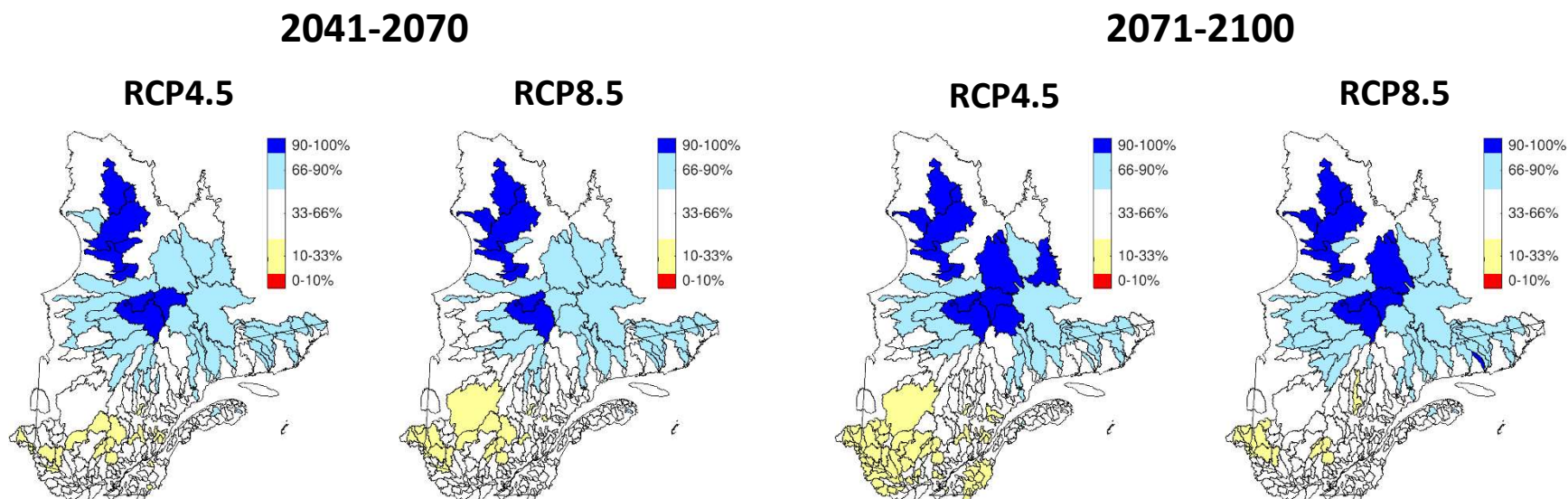
2041-2070

2071-2100



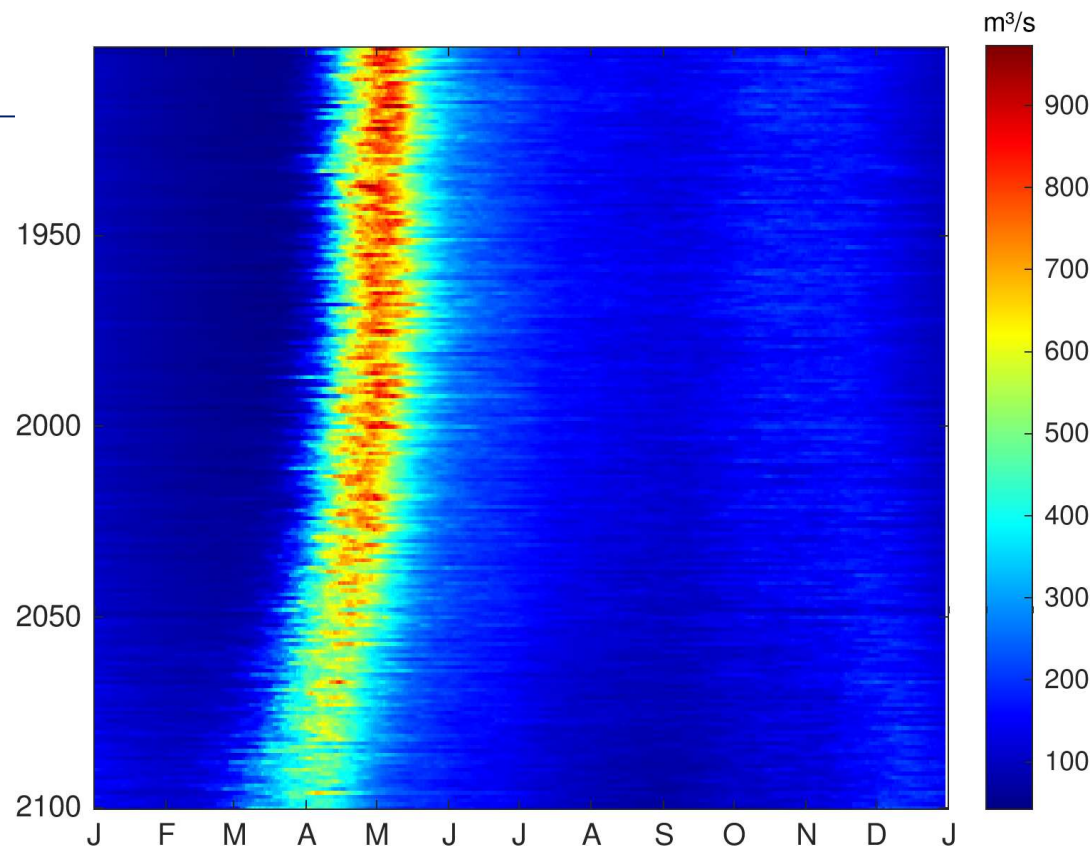
cQ2 | RESULTS

- **Change in mean annual streamflow** – CMIP5 ensemble, continuous simulations, quantile mapping with detrending, control period : 1991-2020.



cQ2 | RESULTS

- “The hydrological sunset” : an example of continuous time series analyses
 - RCP8.5, Baskatong watershed (south of Québec)
 - Inspired by *Raster-based streamflow analysis*, R. Koehler, 2004



CONCLUSION AND FUTURE WORK

- The cQ2 database was contributed to several projects both at Hydro-Québec and with partners (universities, gov agencies, etc.)
- Upcoming : Update of the hydrological projections for dams refurbishment studies

M. Minville *et al.*, "Improving process representation in conceptual hydrological model calibration using climate simulations," *Water Resour. Res.*, pp. 5044–5073, 2014, doi: 10.1002/2013WR013857. Received.

Guay, C., Minville, M., & Braun, M. (2015). A global portrait of hydrological changes at the 2050 horizon for the province of Québec. *Canadian Water Resources Journal / Revue Canadienne Des Ressources Hydriques*, 40(3), 285–302.
<http://doi.org/10.1080/07011784.2015.1043583>



Ministry of
Forest, Wildlife
and Parks



Town of
Québec and
Ouranos



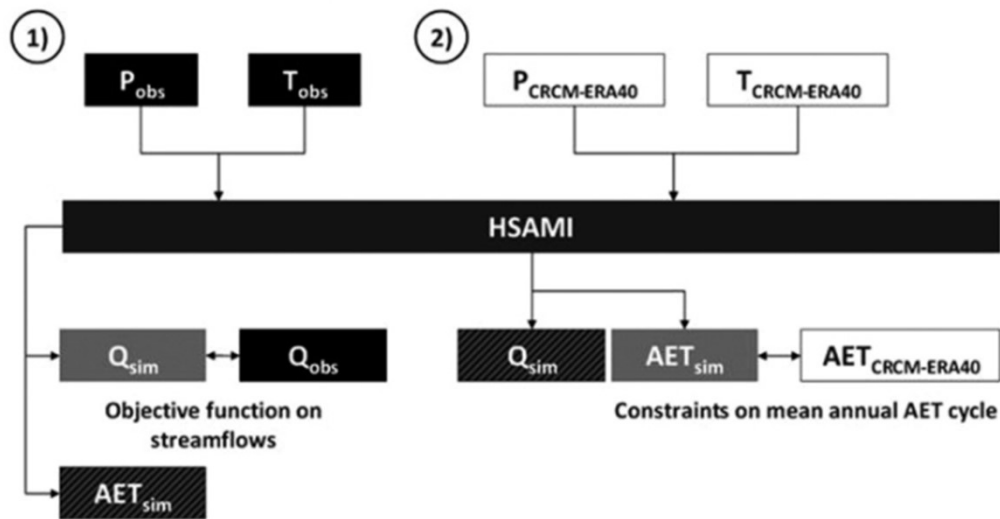
Watershed
management
committee

Merci beaucoup!
tack så mycket !



cQ2 | HSAMI MODEL - CALIBRATION

- Potential evapotranspiration(PET) based on temperature
 - Overestimation issues under a changing climate
- Use of a parallel calibration strategy to set PET parameters



M. Minville *et al.*, "Improving process representation in conceptual hydrological model calibration using climate simulations," *Water Resour. Res.*, pp. 5044–5073, 2014, doi: 10.1002/2013WR013857. Received.