

Climate change and Hydro-Québec: Research and challenges



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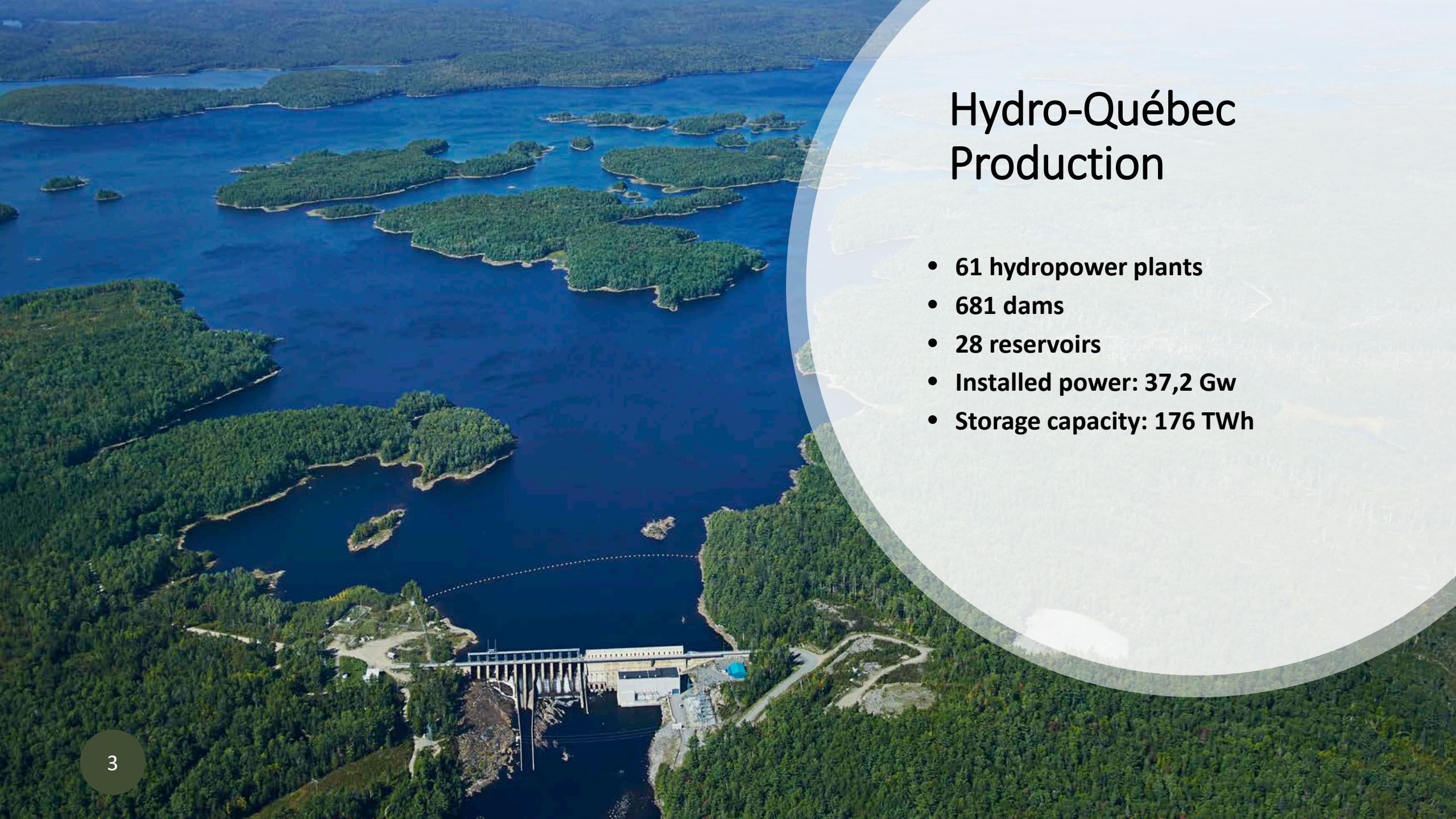
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Outline

- **Context**
 - What is happening in Québec ?
- **Research in Climate Change : « CLIMATOLOGIE » project**
 - What have we done so far ?
 - Where are we going ?
- **CQ2**
 - Task force for improved assessment of climate change impacts on hydrology and hydropower in Québec

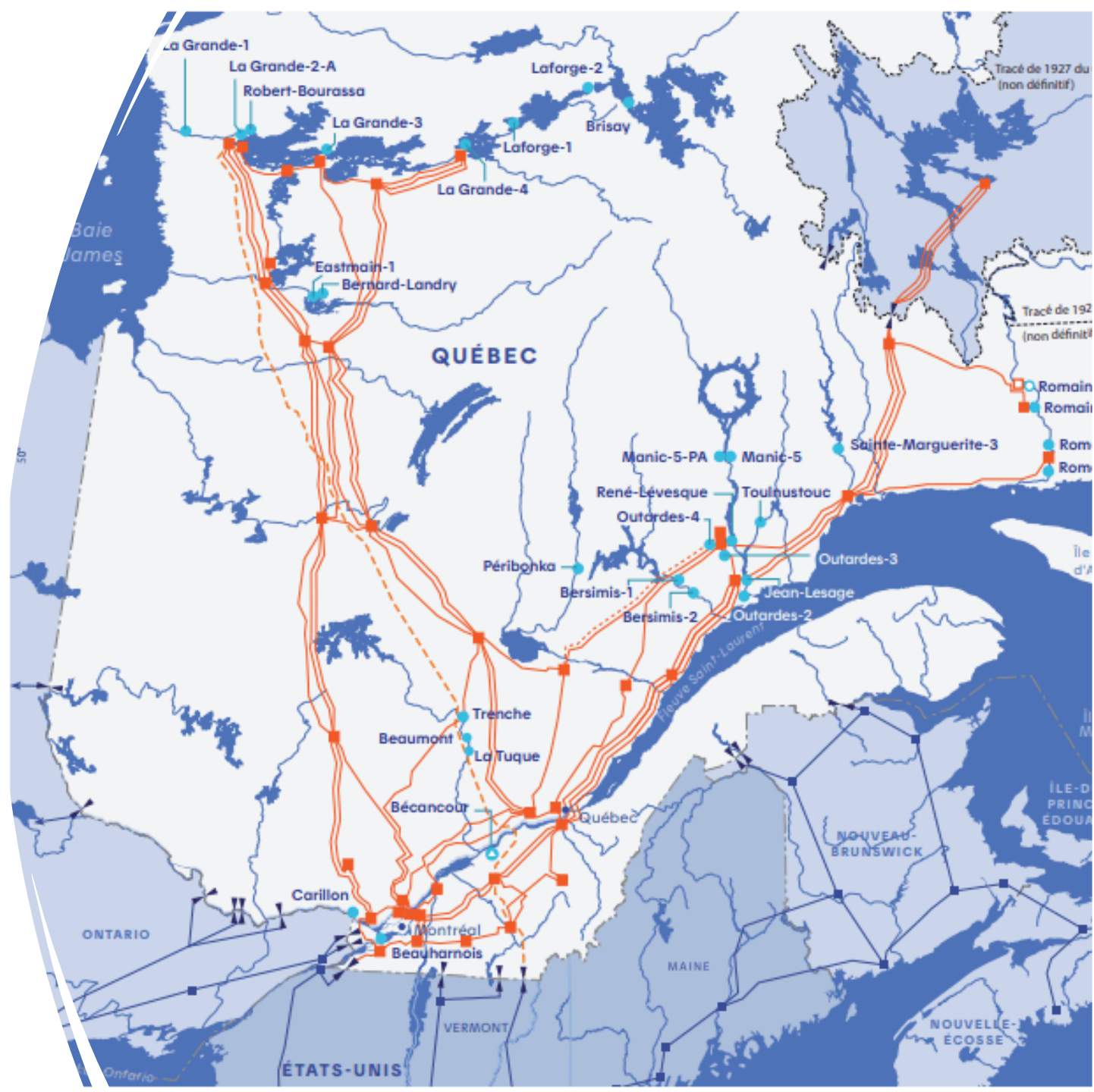


Hydro-Québec Production

- 61 hydropower plants
- 681 dams
- 28 reservoirs
- Installed power: 37,2 Gw
- Storage capacity: 176 TWh

Hydro-Québec Trans-Énergie and Distribution

- 34,000 km of transmission lines, one third of which is very high voltage (735 kV)
- 533 stations from 44 kV to 735 kV
- 15 interconnections that allow electricity exchanges with the Atlantic provinces, Ontario and the northeastern United States
- Interconnection's capacity :
 - Importation : 6 025 MW
 - Exportation : 7 974 MW



Trigger events

Awareness for society and Hydro-Québec

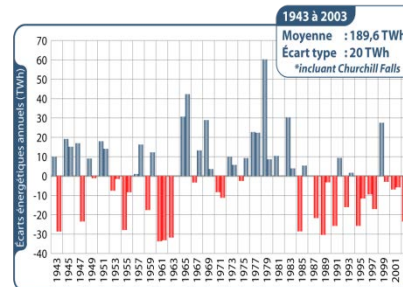
1996 – Saguenay
Exceptional flood



1998 - Montérégie
Major Ice Storm



1985-2001 – Energy
deficit
Low hydraulicity

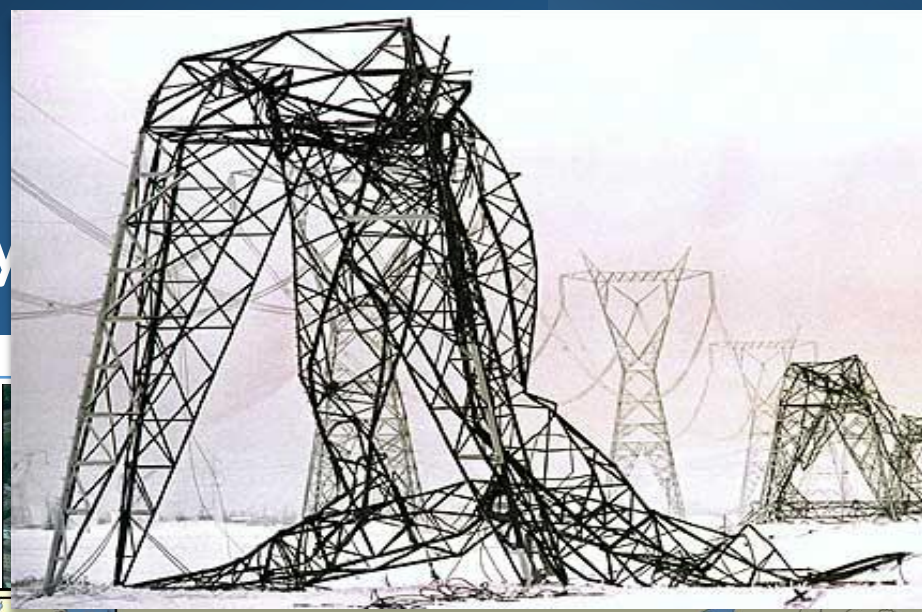


Trigger events

Awareness for society and Hy

1998 ICE STORM

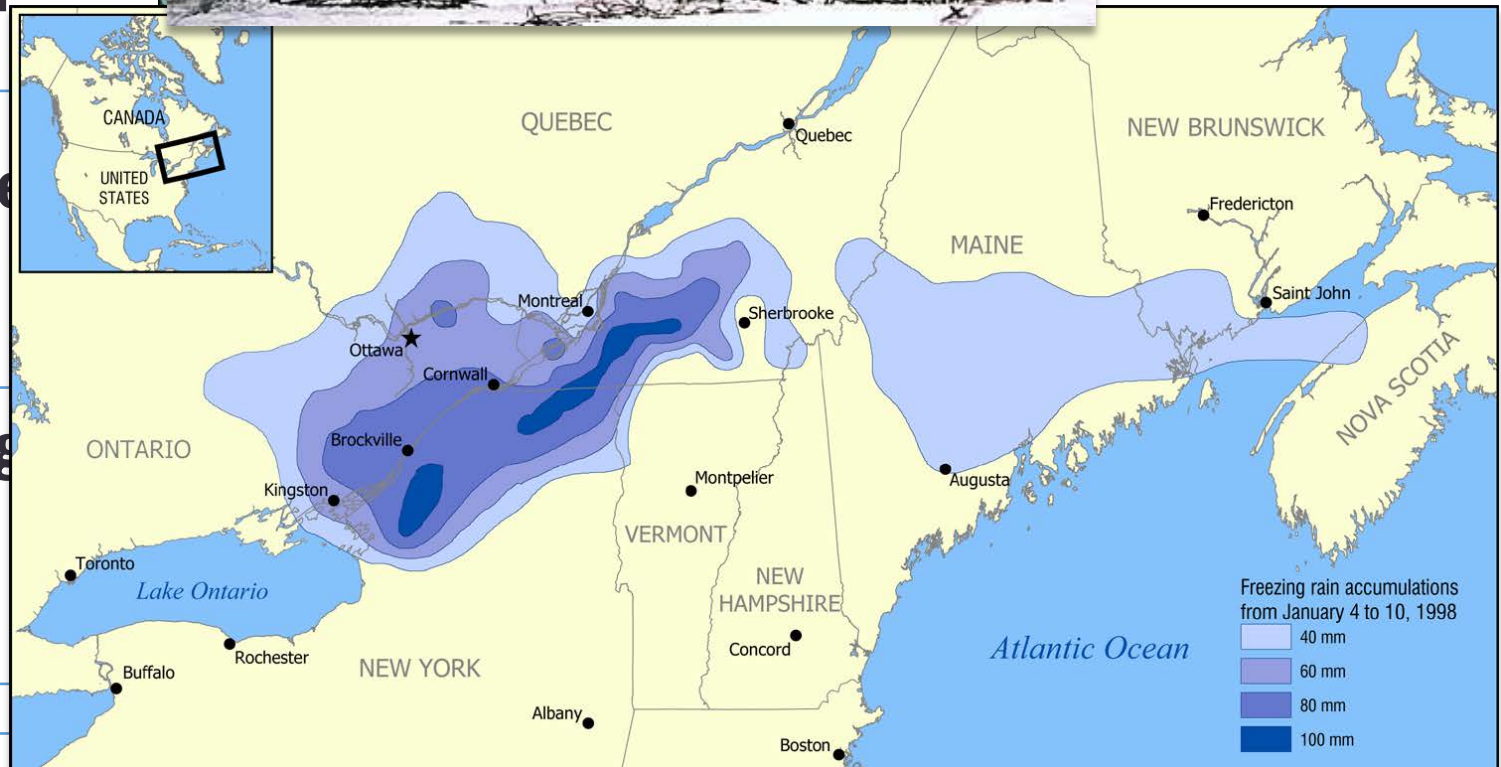
- 5 days, 100 mm of freezing rain
- 35 deaths
- Over 1K electrical pylons and 35K wooden utility poles collapsed
- 4M people without electricity, some for more than 4 weeks



Major Ice Storm

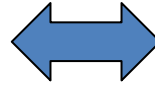
1985-2001 – Energy deficit

Low hydraulicity



What have we done so far?

Co-founded **OURANOS**, a research consortium on climate change and we started a strategic project **CLIMATOLOGIE**



Project « **Climatologie** »

Consortium on regional climatology and adaptation

Internal project created alongside Ouranos foundation.

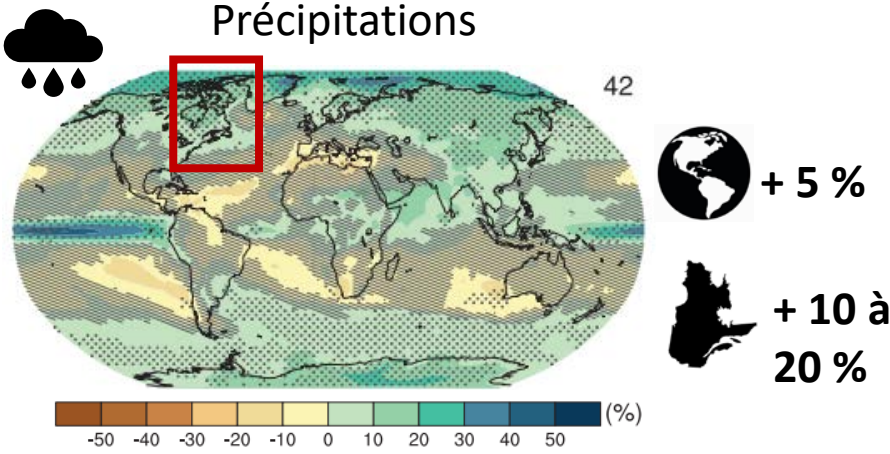
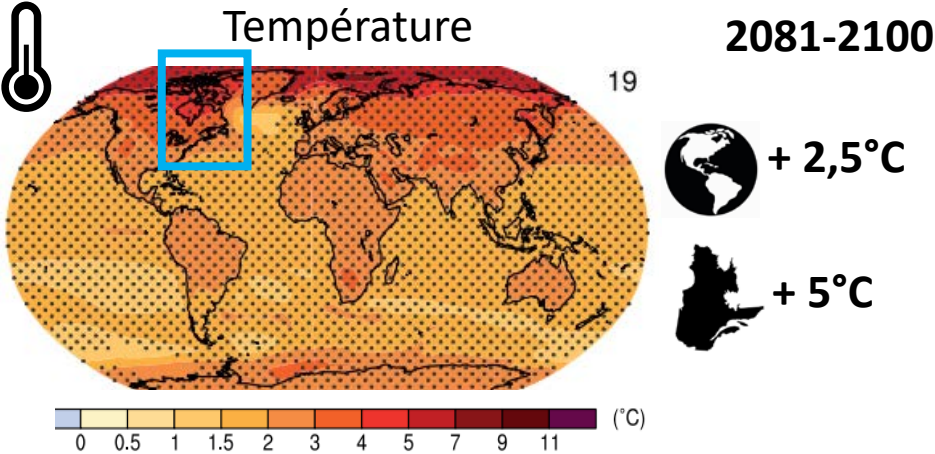
Created in 2002 with the aim of **unifying the effort in Québec on **a shared problematic****

- **Participate** in researchs
- **Build** new methodologies
- **Transfer** knowledge
- **Develop** new approaches
- **Train** highly qualified personnel

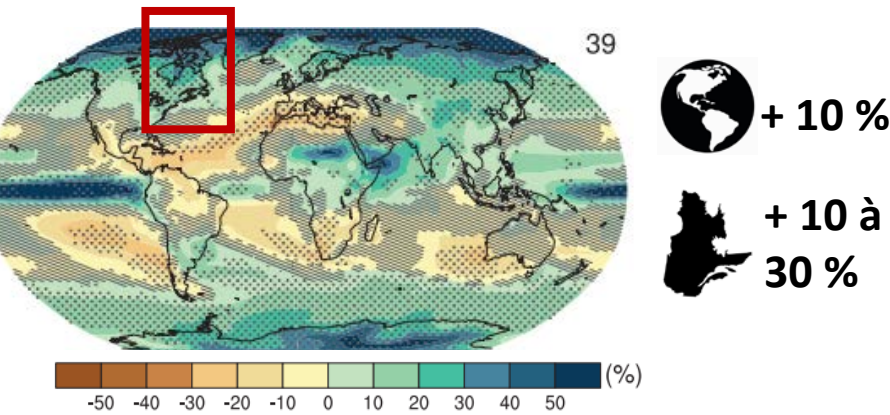
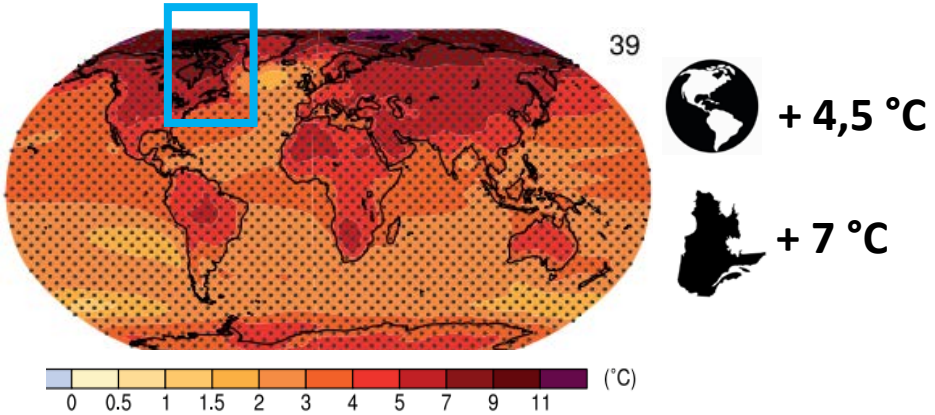
Climate Change

Local impacts

RCP4.5



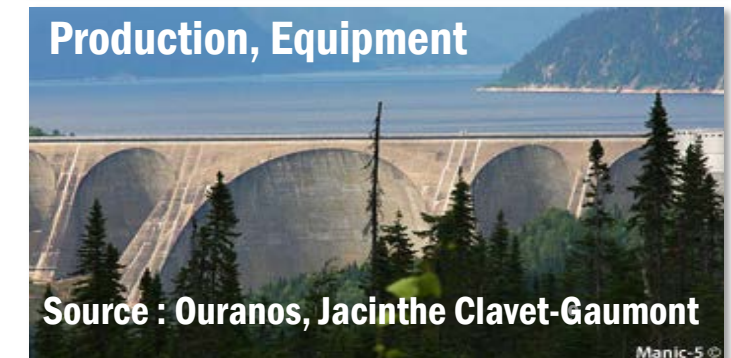
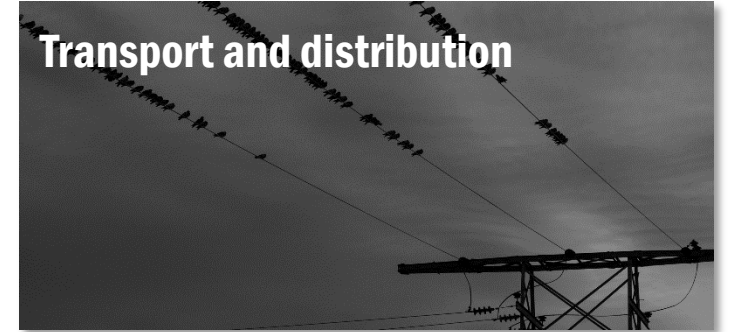
RCP8.5



Northern latitudes are more impacted

Why should we care about CC?

Our activities and infrastructures are profoundly dependent on weather and climate



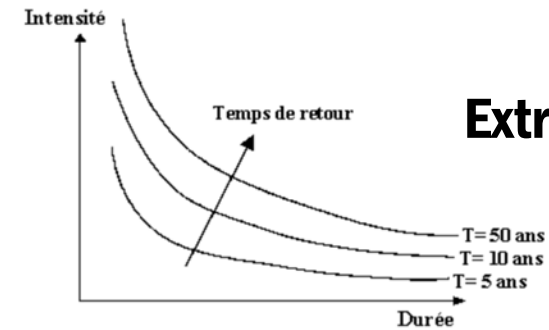
Source : Ouranos, Jacinthe Clavet-Gaumont

What have we done so far ?

Main research topics



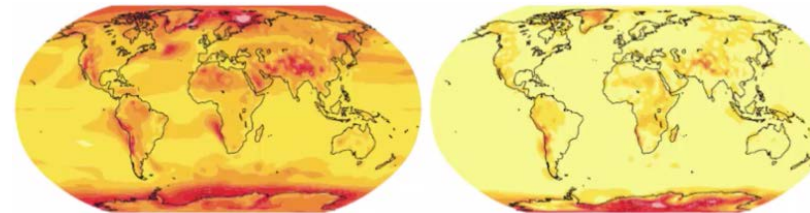
CC impact on energy resources



Extremes events



Demands prediction



Bias correction

What have we done so far ?

Applied science and expertise

Wind energy potential in coming decades

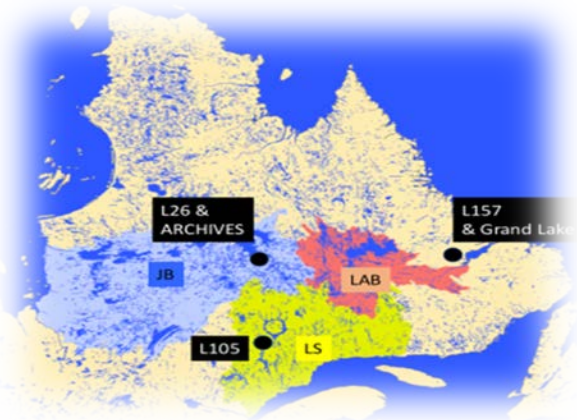
- Objective : Repowering of the installations
- Better production management
- Better understanding of complex weather process such as frost and losses due to those events (climate modelling)

Wildfire risk (La Grande region)

- Wildfire risk maps using a very high resolution fire propagation simulator to map the variability of the fire risk in the La Grande hydroelectric complex. These maps make it possible to compare, by means of a cost-benefit analysis, the desirability of different mitigation measures for the assets most exposed and most vulnerable to fires.

What have we done so far ?

Applied science and expertise



Persistence project, energetic security

- Low record data, climate models limitations
- Risk of persistent low hydropower in the hydroelectric basins of Quebec-Labrador: a millennial perspective.
- Estimate the risk of persistent drought in the Quebec-Labrador region by combining the information contained in the hydrological time series at the millennium scale (rings, sedimentary sequences) with future trends described by climate models in order to improve the estimation of the risk of persistent low hydraulicity in the future.

Dendrochronology

- Multicentury reconstruction of streamflow for the Abitibi River basin and estimation of future climate changes impacts
- Provide a two-century reconstruction of the spring and summer river flow for the Abitibi River basin and to provide a reconstruction of the drought during the same period.



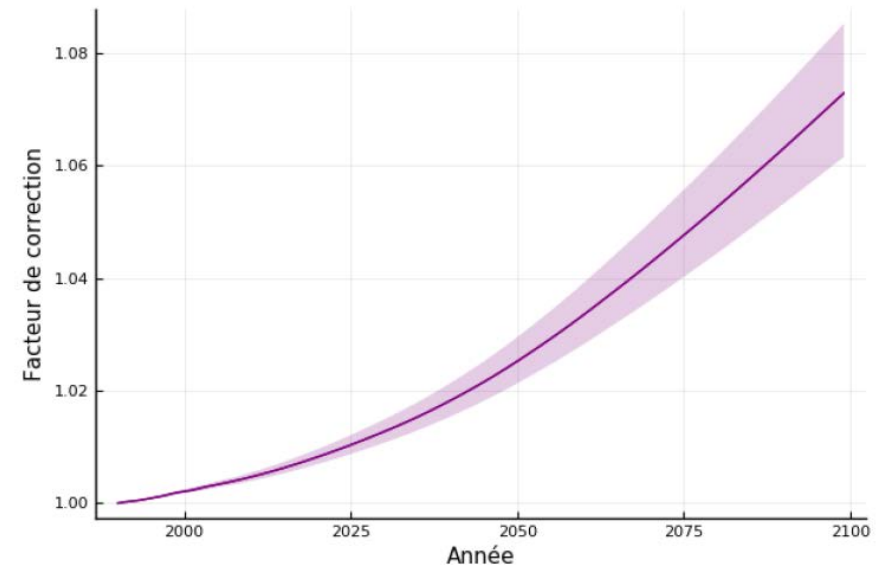
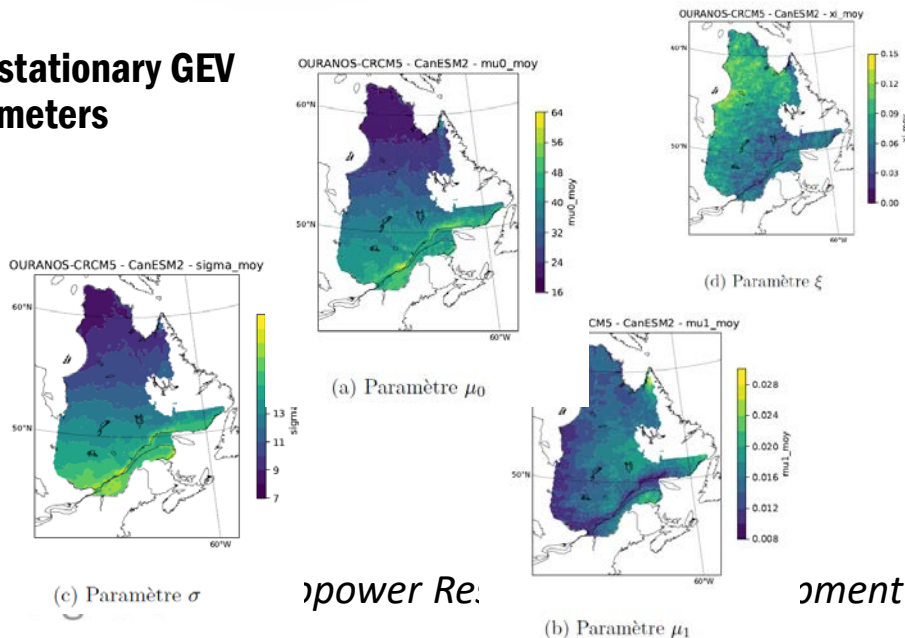
What have we done so far ?

Applied science and expertise - Extremes

Optimization of the performance of water-oil separation systems

- Design and security optimizations
- Sound design : Avoid oversizing by using wrong IDF curves

Non-stationary GEV parameters



Source: Éloïse Nolet-Gravel (2019), Changements projetés des précipitations extrêmes au Québec

Contact : Luc Perreault (IREQ), Jonathan Jalbert (Polymtl)



power Re.

ment Days, October 6-7th

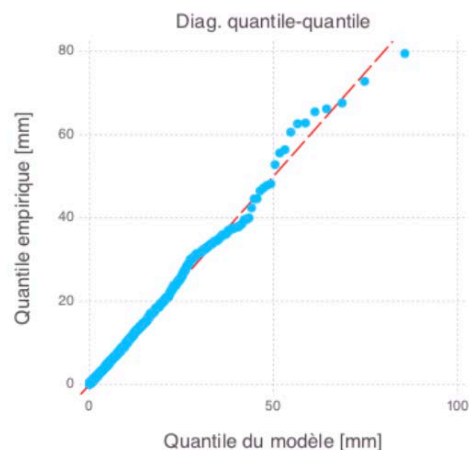


What have we done so far ?

Applied science and expertise – Extremes bias correction

Objectives: Develop a parametric post-processing method adapted for **extreme** values and the **core** of the distribution of simulated precipitation.

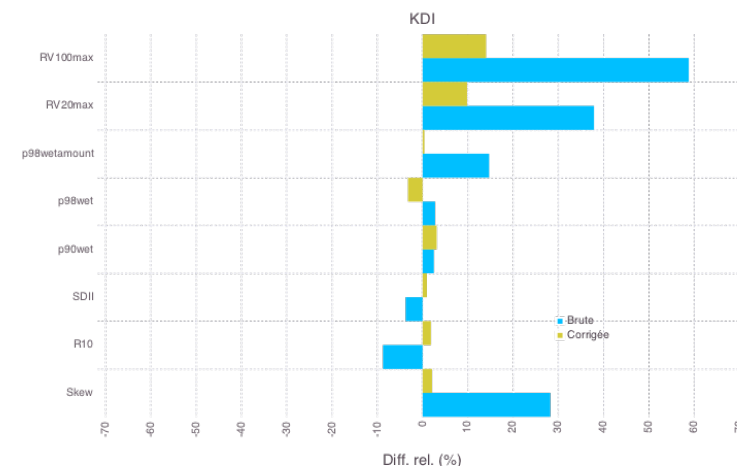
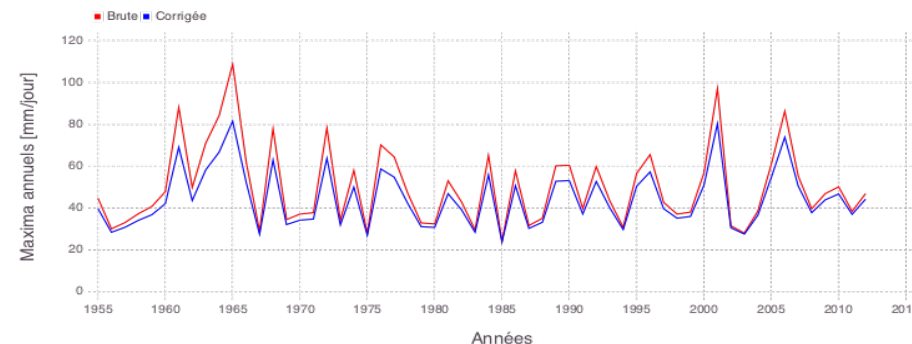
Challenge: To properly model the extremes, parametric methods are required. Current post-processing methods usually estimate distributions non-parametrically, decreasing the estimation accuracy in the tails.



Methods: Parametric distributions (Naveau et al., 2016) modeling both the core and tails of the distribution in line with EVT were adapted to the post-processing context.

A **non-stationary extension** was developed to take into account the non-stationarity of the simulated precipitation. The method was validated on the observations by computing suitable indices for the core and the tails.

Results: It was determined that one of these parametric distributions was adequate to model the observations and simulations. Validation indices show an **improvement** compared to the raw simulations and post-processed by standard methods such as quantile-quantile.

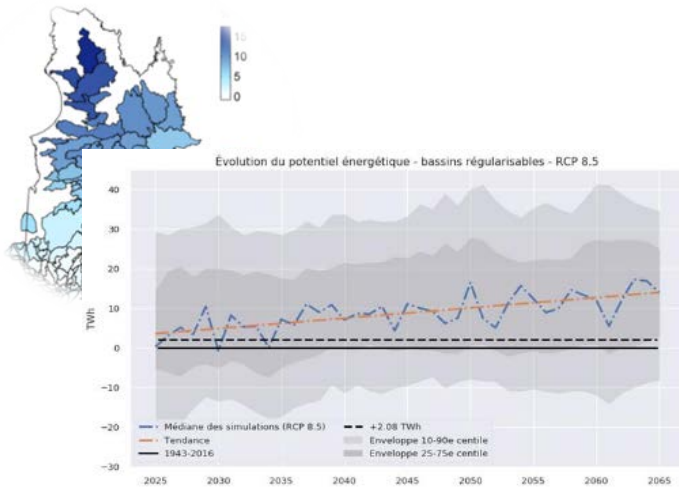


Source: Gabriel Gobeil (2021), Development of a post-processing method for extreme precipitation

Contact : Jonathan Jalbert (Polymtl), Philippe Roy (HQ)

What have we done so far ?

ADVANCEMENT OF KNOWLEDGE AND DEVELOPMENT OF NEW METHODOLOGIES



Hydroelectric potential in coming decades

Stay tuned!



Assets value

Integrate climate change into assets evaluation.

Methodological framework for assessing hydropower resources in the context of climate change. It address the economic value of flow fluctuations, structural or operational modifications and more generally, the evaluation of adaptation options.



Maximum probable flood and design-flood values

Support engineers with updated hydrology for design-value projects, notable dams and spillways

Where are we?

Conscience and actions

- In its Strategic Plan 2020–2024, the company undertook to develop an adaptation plan aimed at mitigating climate risks.
- In 2020, a committee made up of representatives from all the units concerned identified **key vulnerabilities** in order to propose **adaptation measures** and, in due course, oversee their **implementation**.
- The company asserted its intention to be a **leader** in the energy **transition** so as to make a substantial contribution to the fight against global warming.

Catherine's presentation

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