Estimation of Energy Demand Taking into Account climate change in Southern Québec

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In collaboration with
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Alternative Climate Normals Workshop
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▪ Ouranos : Consortium on Regional Climatology and Adaptation to Climate Change

Members (since 2001)

Québec

Departments:

1. Public security
2. Sustainable development, Environment and Parks
3. Natural Resources and Fauna
4. Municipal Affairs and Regions
5. Transport
6. Agriculture, Fisheries and Food
7. Economic Development, Innovation and Exports
8. Health and Social Services

Hydro Québec

Environnement Canada
Environment Canada

UQÀM
Université du Québec à Montréal

McGill

Université Laval

INRS
Université d'avant-garde

Affiliated members (since 2007)

Manitoba Hydro

Université du Québec
École de technologie supérieure

UQAR

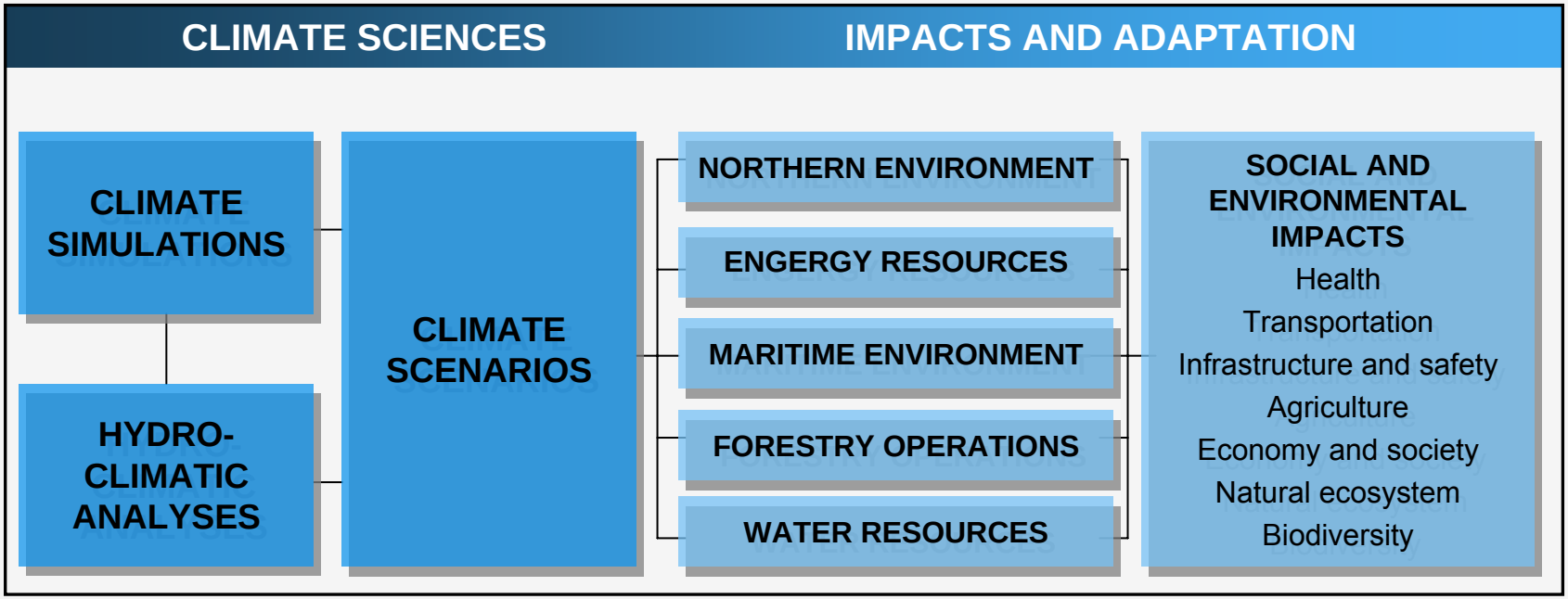
Ontario Power Generation

Mission

AQUIRE + DEVELOP knowledge
INFORM + ADVISE decision-makers and stakeholders

Structure of the Consortium

- 2 Main Themes
- 9 Programs
- Multiple projects



Outline

Part 1

Adjustment of mean temperature

- Southern Québec situation
- Definition of reference period
- Climate change scenario for Southern Québec and its use
- Impact of warming on electric demand

Part 2

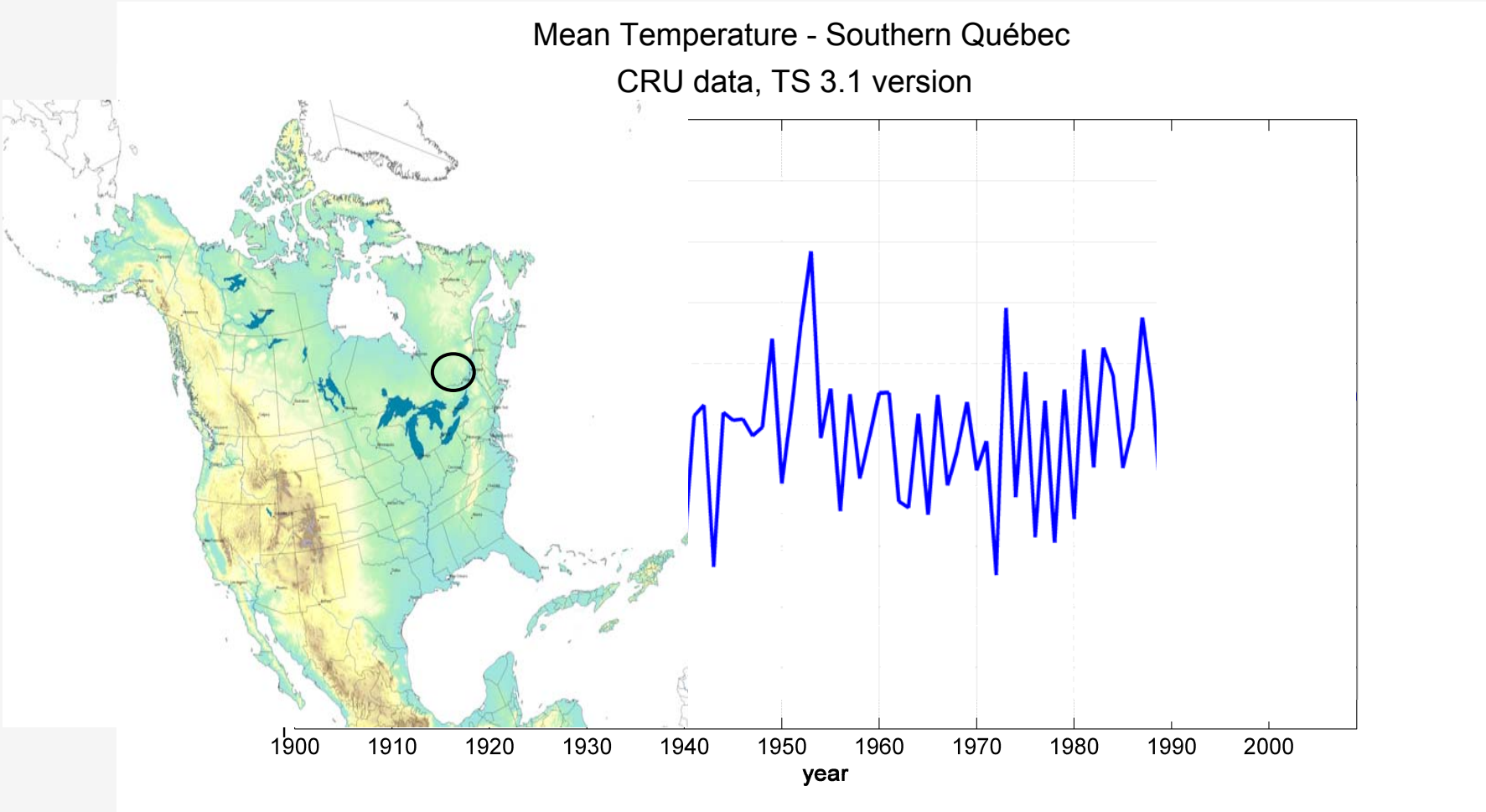
Analysis of extreme

- Context
- Extreme temperatures projected trend: preliminary results
- Next steps

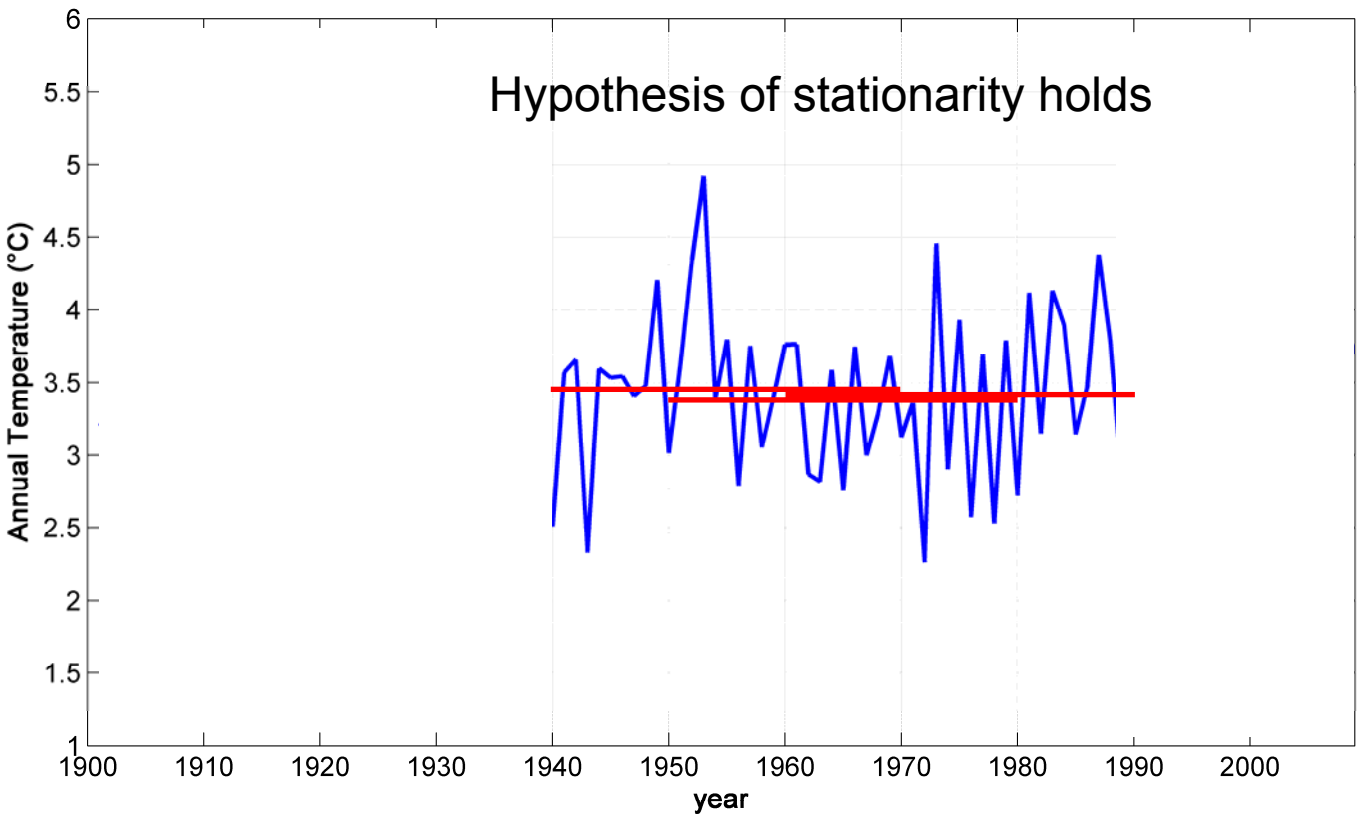
Concluding remarks

- Electric demand in Québec is highly weather sensitive due to high saturation of electric heating.
- Load and Sales revenue forecasting requires reliable weather and climate information.
- Beyond 10 days, forecasts are made using reference climate for normals
- Last 2 decades (1990's and 2000's) were much warmer in Southern Quebec in comparison to their corresponding 30 year average periods (1960-1990 and 1970-2000).
- **Main issues:**
  - **Is a past 30-year average representative of actual conditions?**
  - **How can anthropogenic warming be taken into account in the estimation of electric demand ?**

Observed Temperature - Southern Québec



Observed Temperature - Southern Québec



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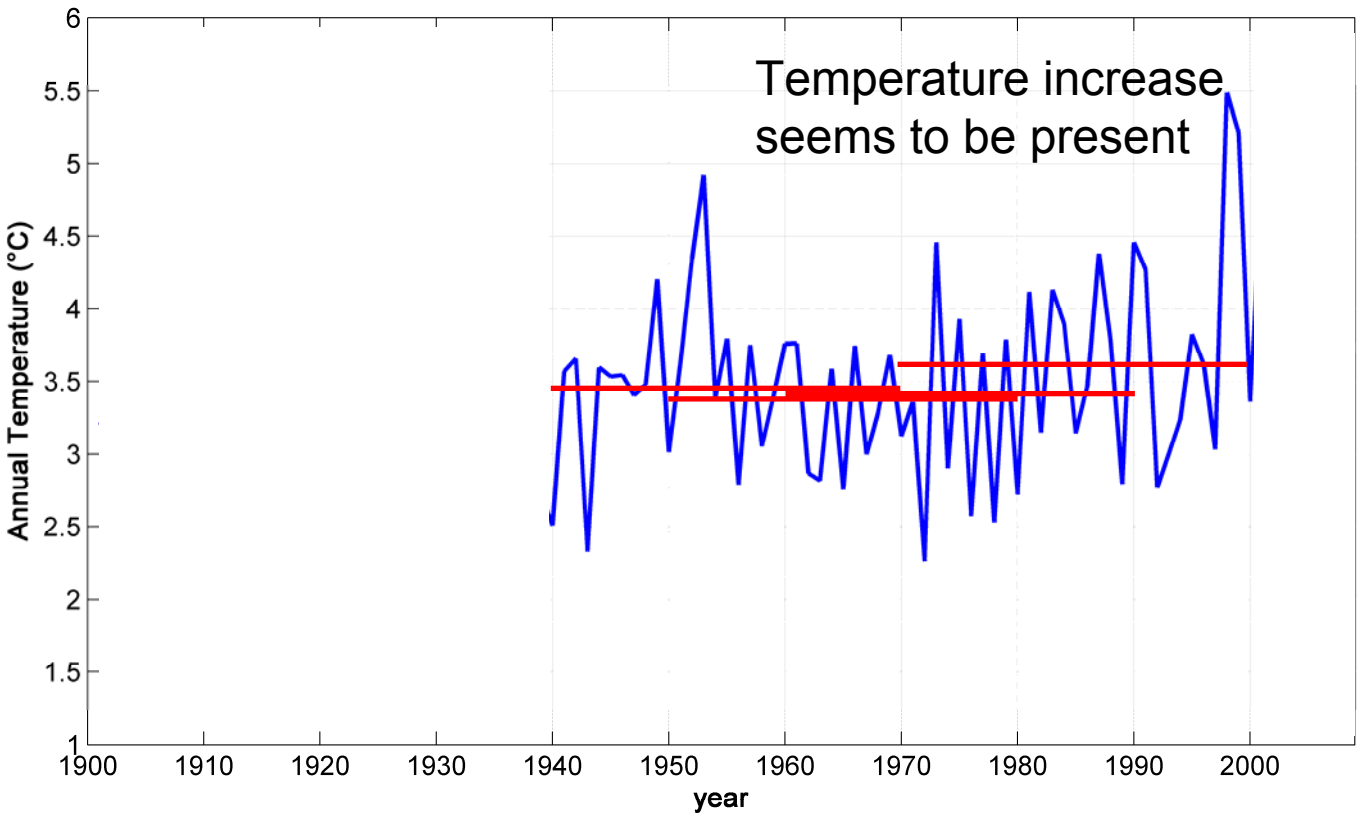

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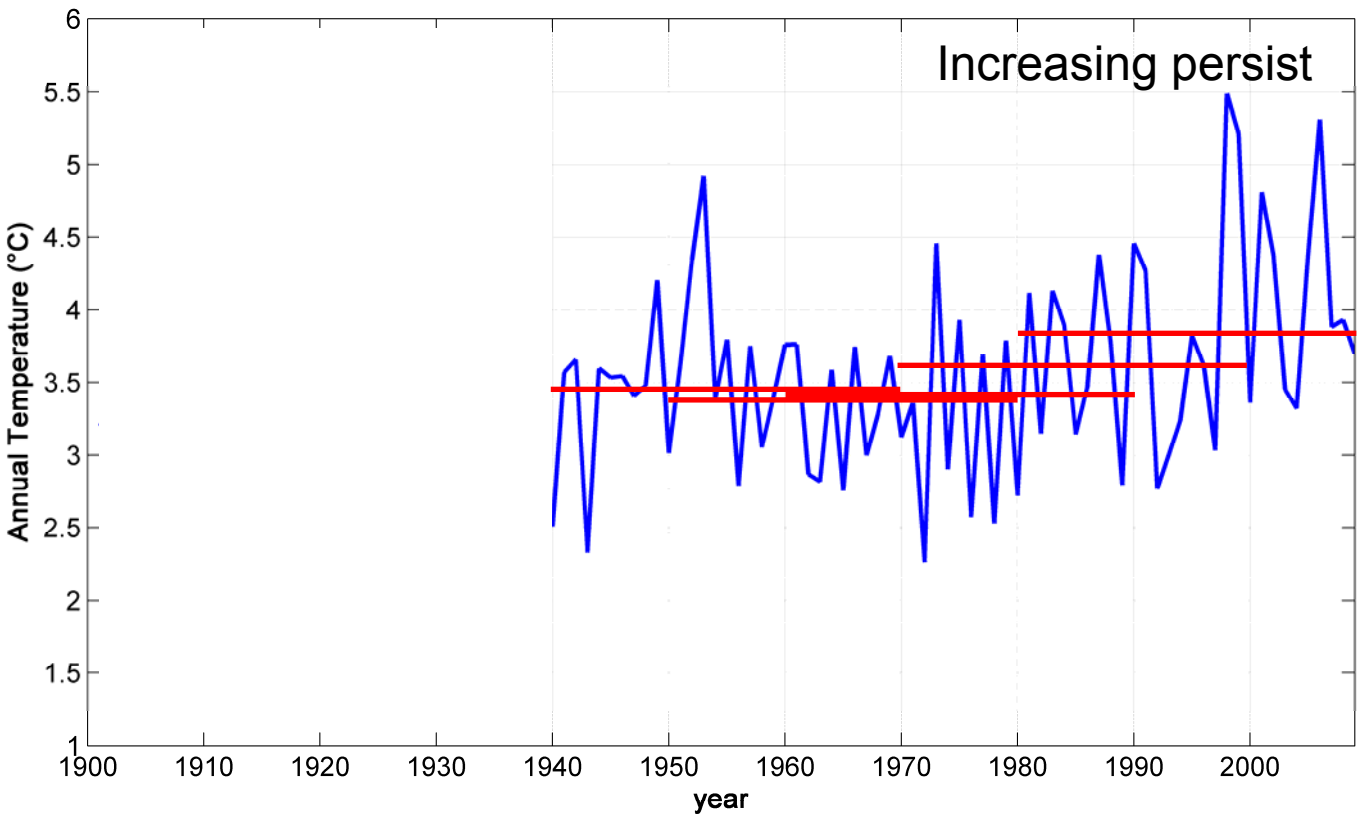
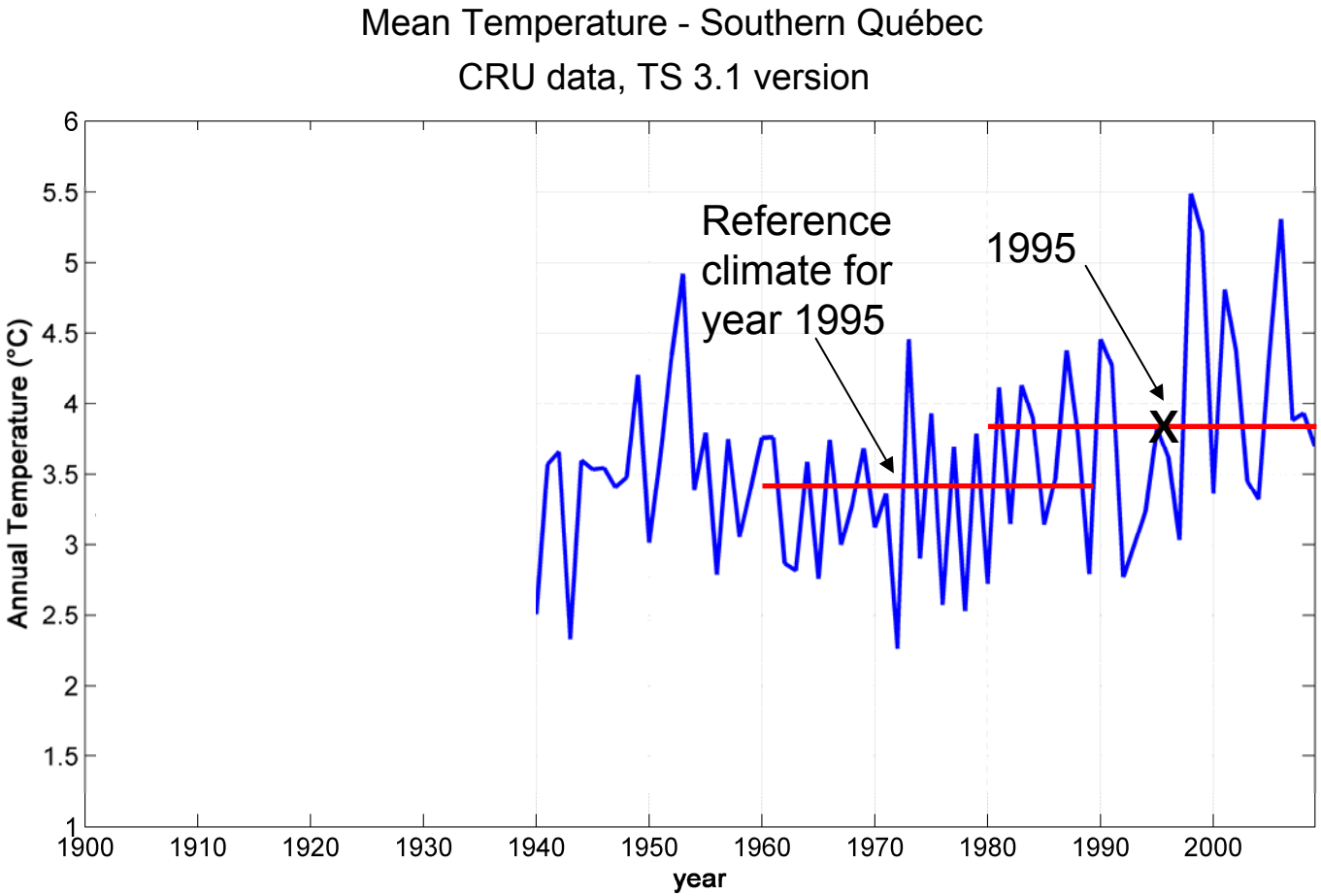
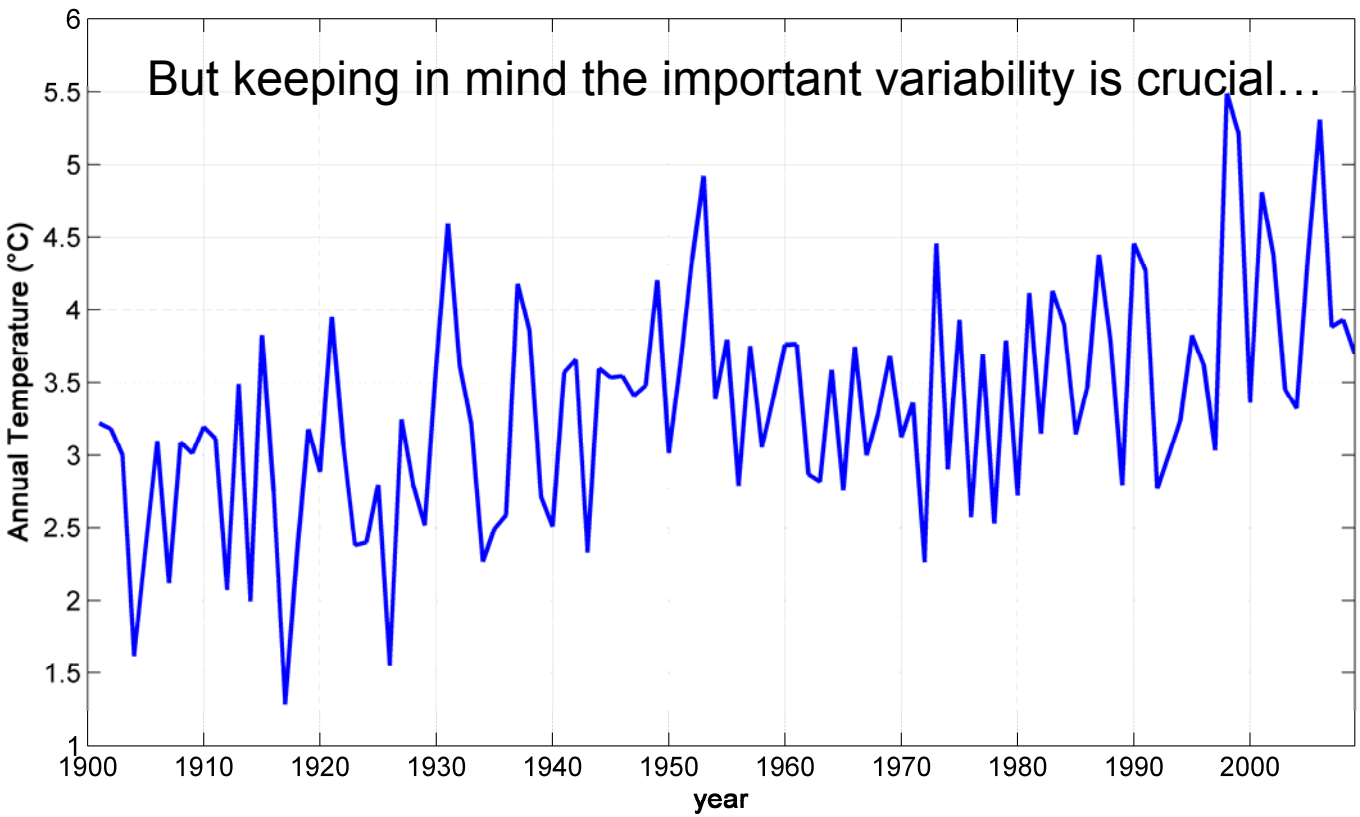


Observed Temperature - Southern Québec



▪Observed Temperature - Southern Québec



History : addressing climate change

- In 2004, research conducted by Ouranos led to a scenario of temperature warming based on one global climate simulation.

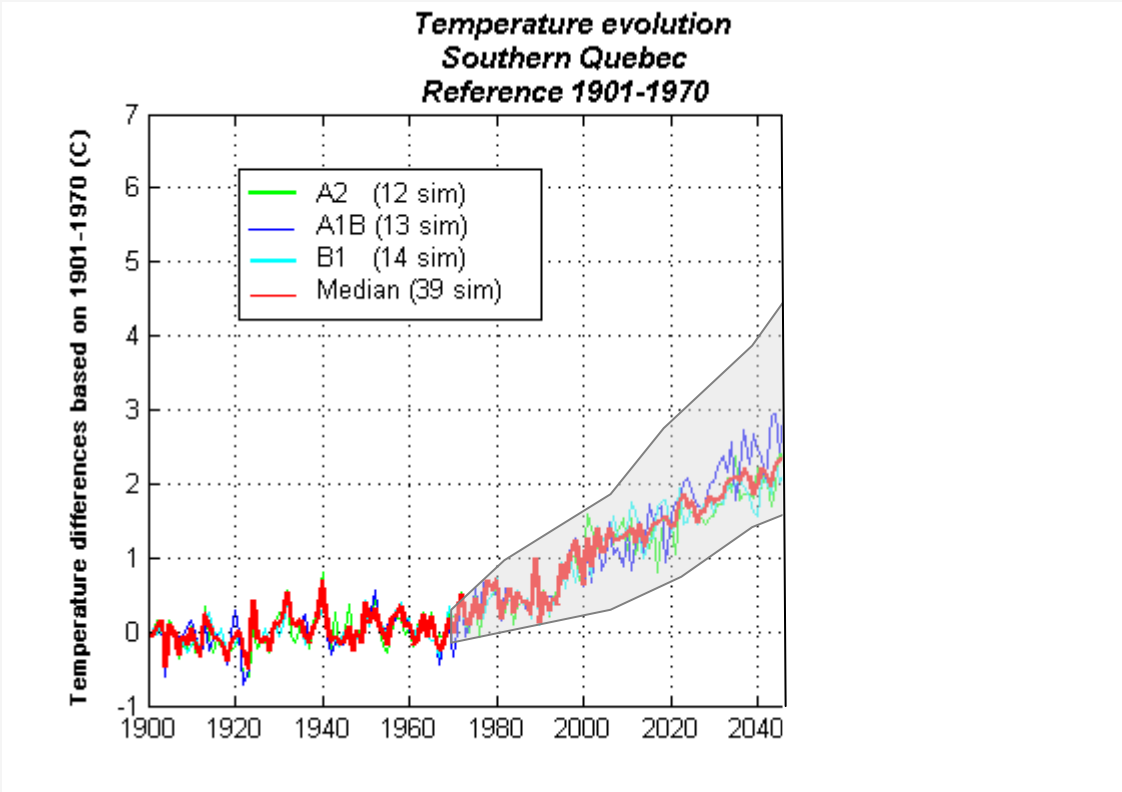
- In 2007, update of the research based on the 4th assessment report of the Intergovernmental Panel on Climate Change (IPCC) and Ouranos
  - Adequacy of reference period in a non-stationary climate
  - Establishment of a rupture point in the temperature evolution as a consequence of anthropogenic warming
  - New warming scenario based on ensemble of simulations

Reference Period for temperature

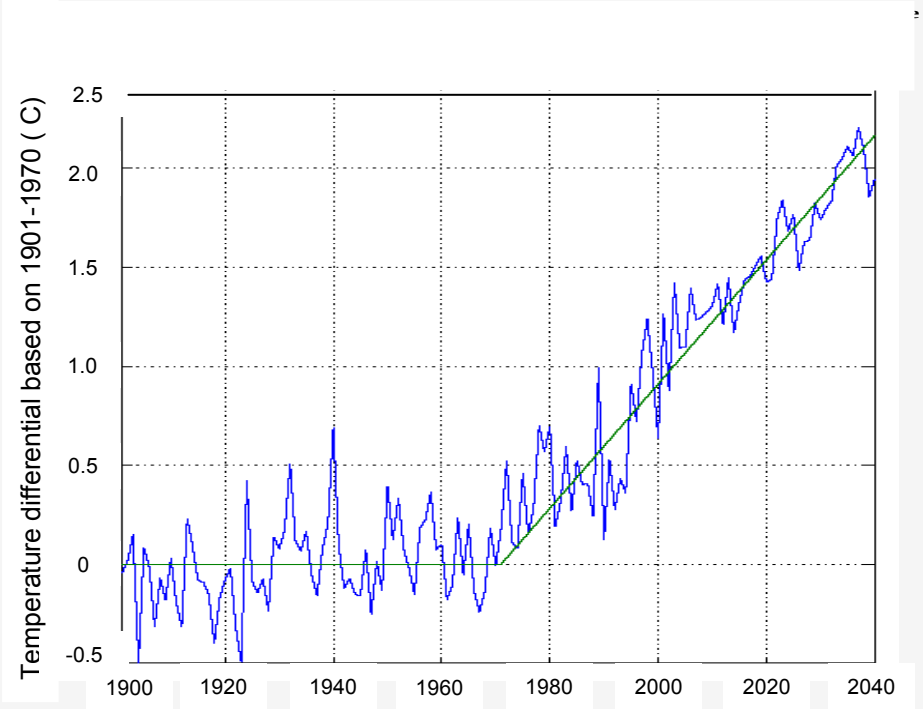
- 30 year period: minimal length of time as climate is concerned; typical reference period for meteorologists and climate experts
- around year 2000, many utilities adopted shorter periods to average temperature; 20 years instead of 30 years, even 10 years to catch more recent years influence.
- 1971-2006: reference period recommended by Ouranos
  - **Includes recent warm years**
  - **Includes climate variability**
  - **Temperature adjusted based on warming scenario**
- Reference period is updated periodically

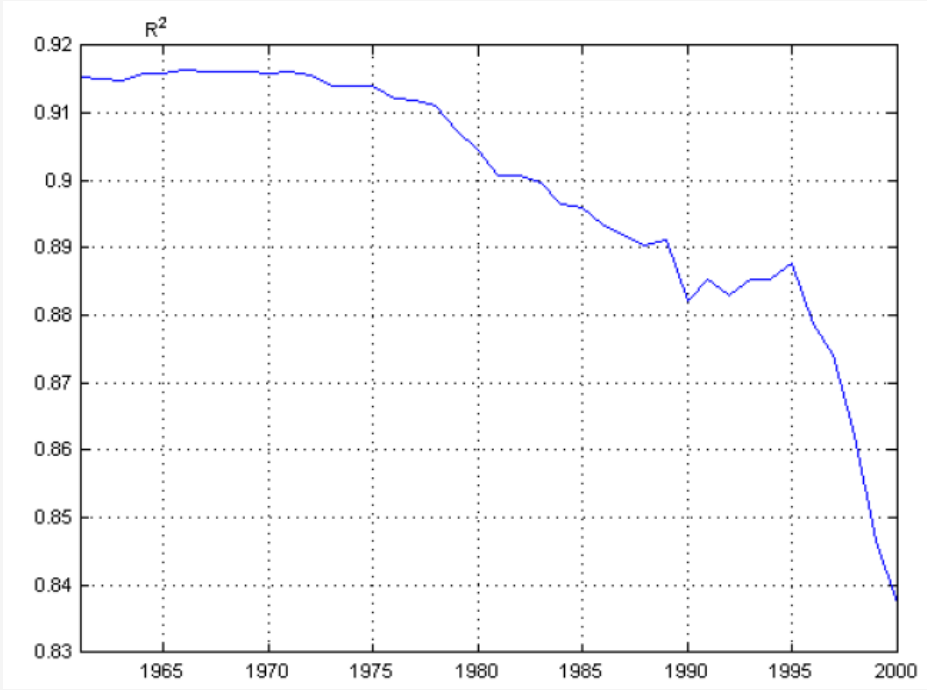
Temperature change simulated in Southern Québec

- 39 simulations: 17 Global Climate Models, 1 to 3 greenhouse gas scenarios
- Differences between GHG scenarios remain small until 2040 (time limit of interest for electricity demand planning)
- Comparison with Regional Climate Model showed no added value for mean temperature in south of Québec



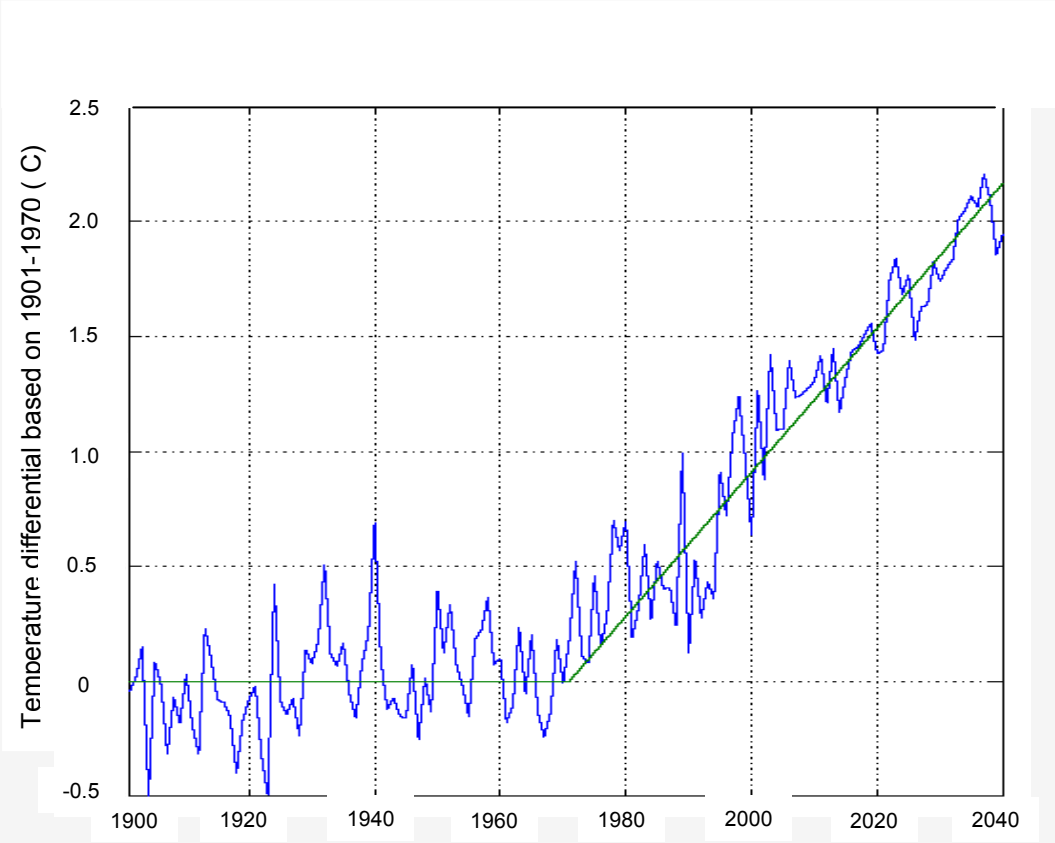
▪Establishment of a rupture point





▪Warming scenario for energy demand

- Median of the 39 simulations
- Assume linear warming trend
- Determination of the optimal rupture point (~1971)
- Conclusion: mean annual warming of 0,3°C/decade applied from 1971

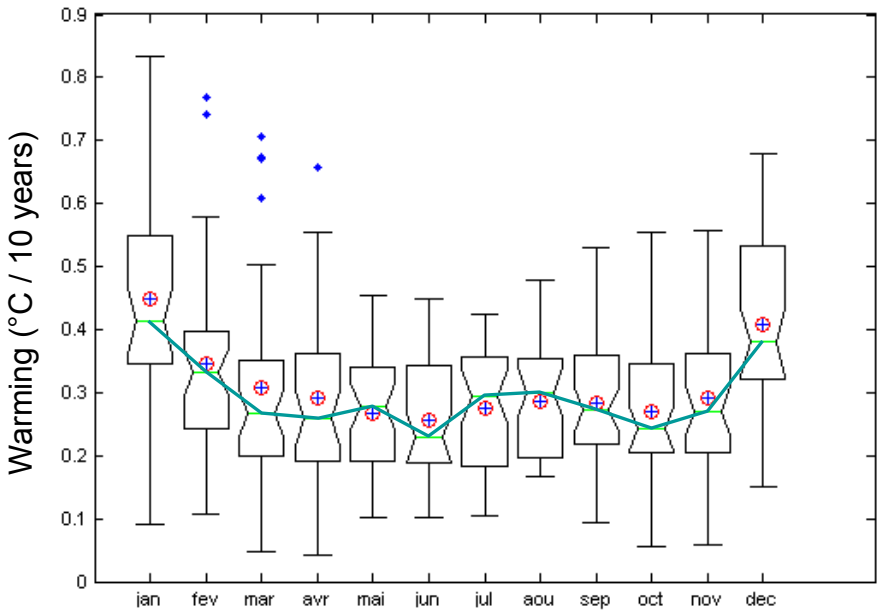


▪Unequal warming and dispersion throughout the year

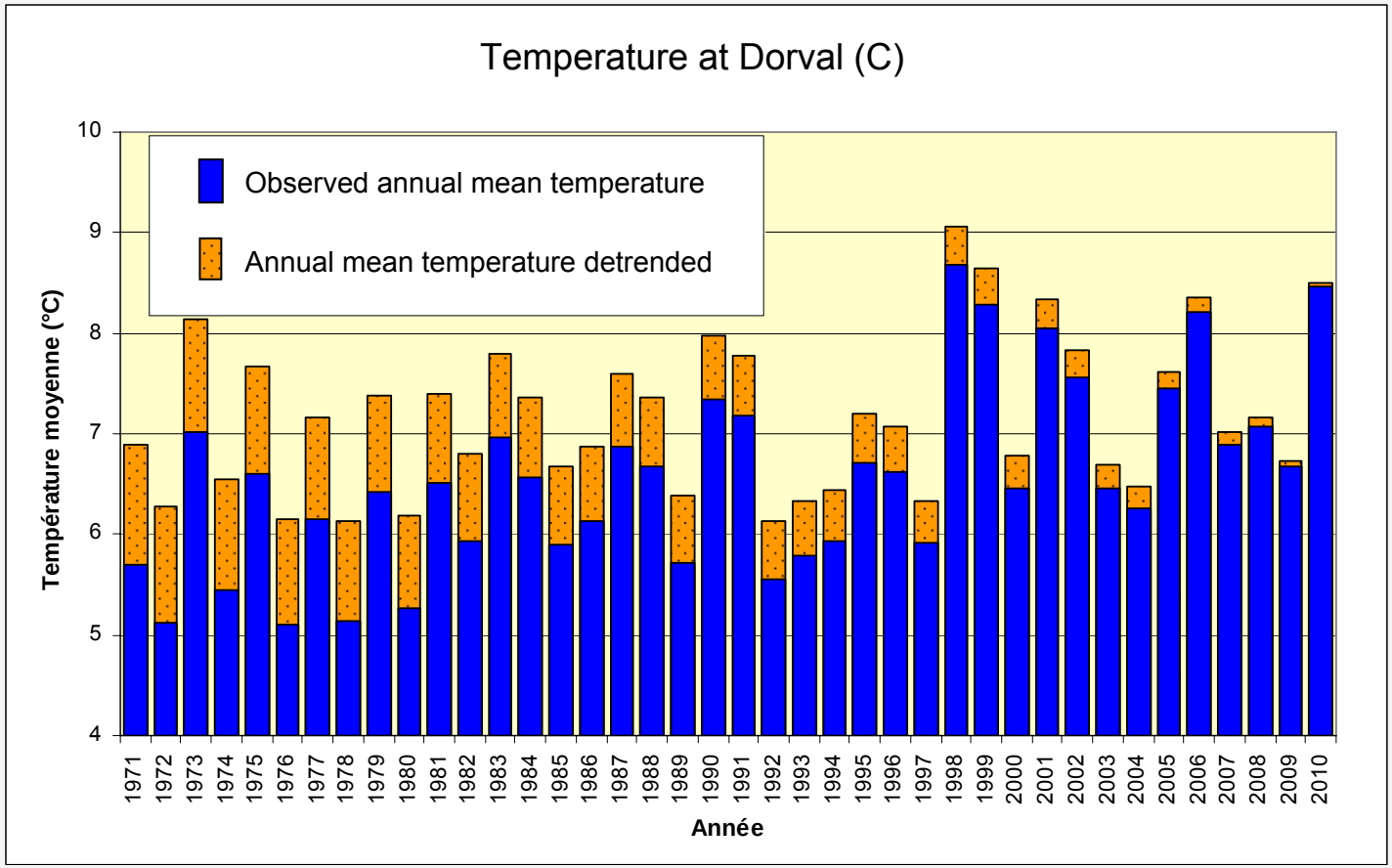
Warming (°C / 10 years)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0,45	0,36	0,27	0,28	0,26	0,23	0,26	0,27	0,28	0,25	0,28	0,39

Boxplot of the monthly warming
for the 39 climate simulations



▪“Adjusted” Temperature for 2011



- **Projection of Heating and cooling : Year 2030**

		Heating		Cooling	
Horizon		**HDD <18°C**	***Relative change (%)***	**CDD >22°C**	***Relative change (%)***
1971-2006	Observed	4677		48	
2030	Projected	4075	-13	91	90

- **Better projection for use in Procurement Plan**

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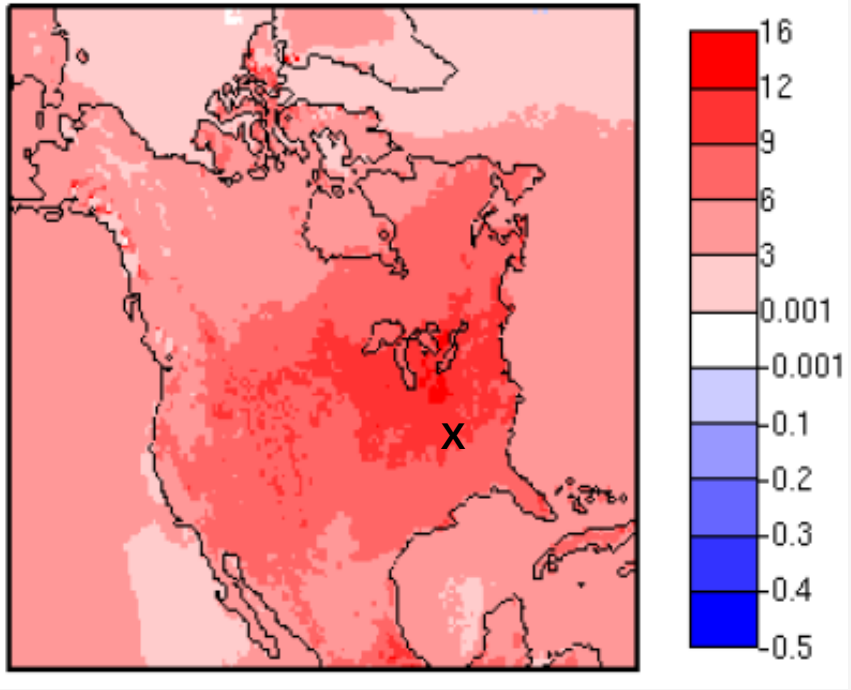
Concluding remarks

- So far, the temperature increment has been calculated on mean temperature. Is this adequate to adjust the extreme minimum temperature, affecting the influence of climate on peak load?

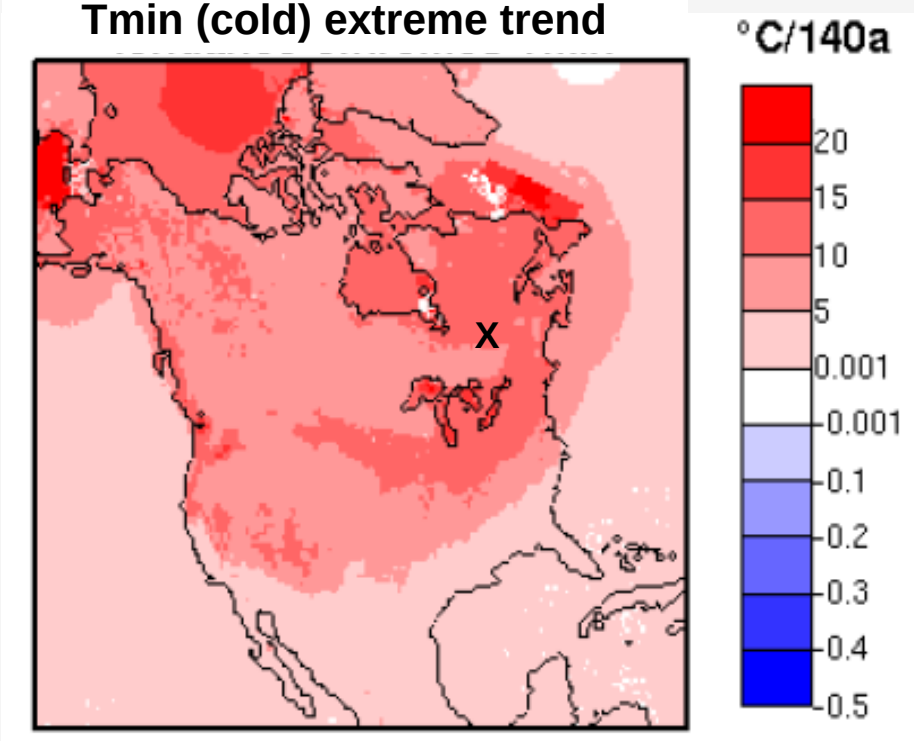
- **Main issues:**
  - **Is the trend in extreme cold temperature similar to the trend in average winter temperature?**
  - **Is there a change in the variability of the extremes?**

Tmax (hot) extreme trend



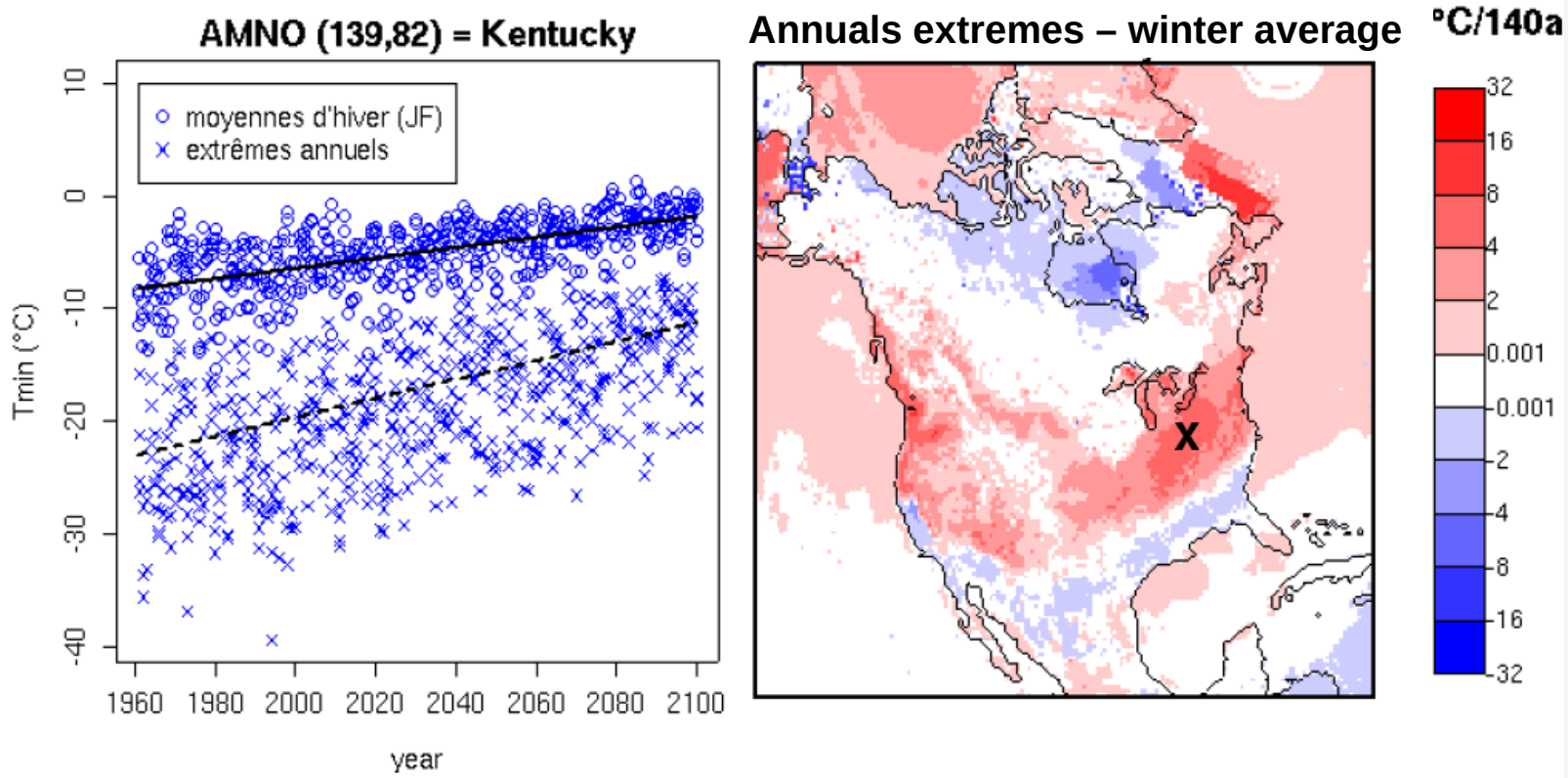
Largest increase over Eastern US.

Tmin (cold) extreme trend



Largest increase over Quebec and South of the Great-Lakes

Tmin trend : annuals extremes – winter average



The warming of the Tmin annual extremes is faster than that of the winter average Tmin along the Pacific Coast and in the Eastern US.

- **Next steps**
  - Analyze cold extremes (trend and variability) in a large ensemble of global climate simulations
  - Finding a method to apply the new adjustment for operational use

Concluding remarks for Mean temperature

Reference period

- Use of longer observation period for reference temperature (1971-2006)

Climate change scenarios

- Adjustment taking into account climate change
- Climate simulations of an ensemble of 39 runs suggest a mean annual warming of 0,3°C / decade with a rupture point around 1971 for southern Québec.

Impact on energy demand

- Methodology should account for climate change effects on electric demand.
- More realistic information for electric load, pricing and procurement planning

▪ Preliminary concluding remarks for extremes

Extreme projected evolution

- Larger warming of hot extreme over Eastern US.
- Larger warming of cold extreme over Québec and Southern Great Lakes

Annual extremes vs seasonal mean

- Projected evolution of cold extreme ≠ evolution of winter temperature over many areas

Analysis in progress with large ensemble of global climate simulations

- Thank you!
- Questions and Comments?