# Climate change science and adaptation decision making

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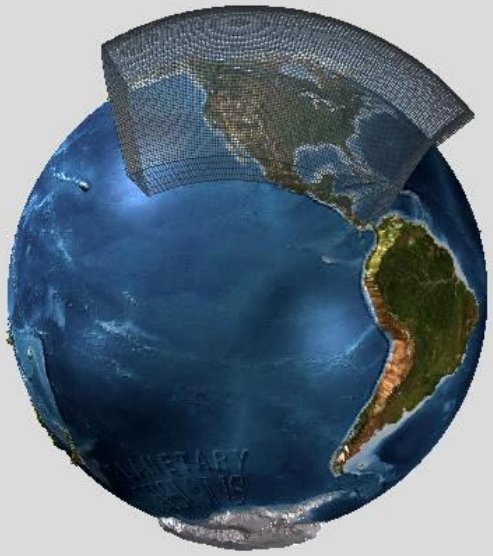
# Ouranos consortium: science serving adaptation

www.ouranos.ca

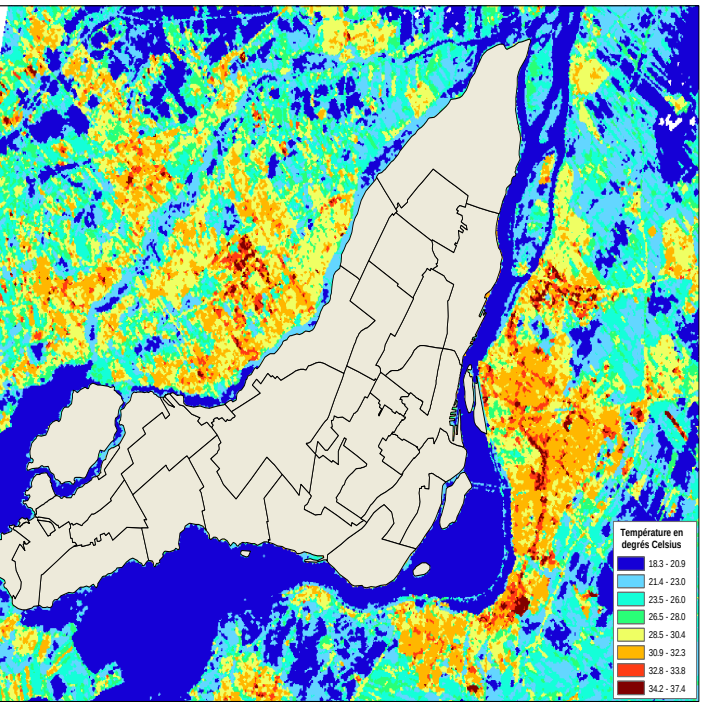


- Based in Montreal, created by members in 2002
- Critical mass of expertise to insure the development and coordination of interdisciplinary, applied and user driven R&D
- Innovation through collaborative research connected to decision making (policy, planning, operations)

1. A program in <u>Climate science</u> dedicated to climate scenarios and regional climate modeling (300km/45km/10km)

2. A multidisciplinary and multi-stakeholder program in <u>Vulnerability, Impacts and Adaptation</u>

- Water resources
- Built environment
- Maritime environment
- Northern Environment
- Ecosystems and biodiversity
- Forestry
- Agriculture
- Energy
- Health
- Tourism
- Economy




Environnement Canada Environment Canada · Hydro Québec · Québec · ONTARIO POWER GENERATION · Université du Québec École de technologie supérieure · McGill · UQÀM Université du Québec à Montréal · INRS Université d'avant-garde · Université Laval · Communauté métropolitaine de Québec · RioTinto · UQAR · Manitoba Hydro

# Accelerated warming for the last 45 years

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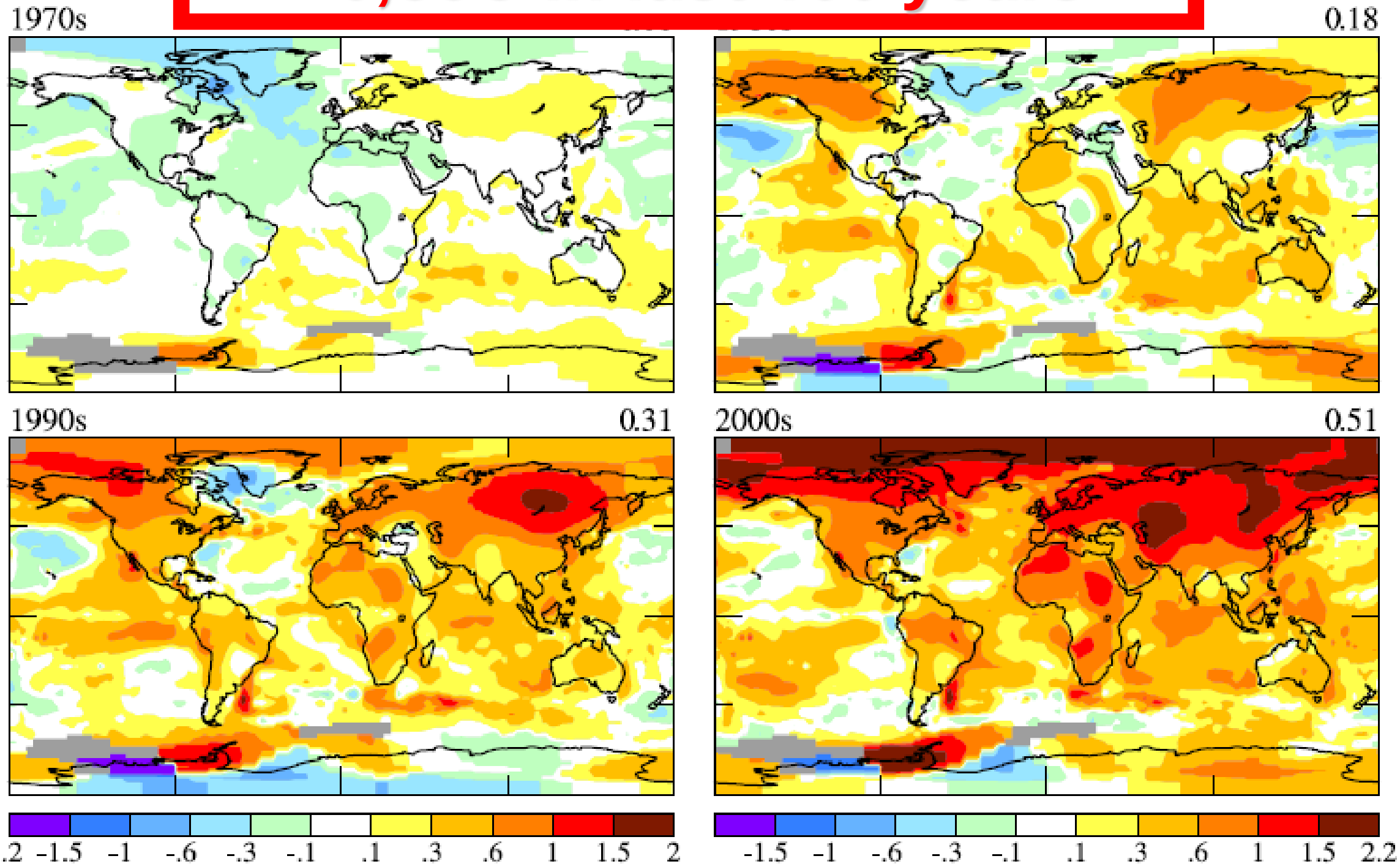
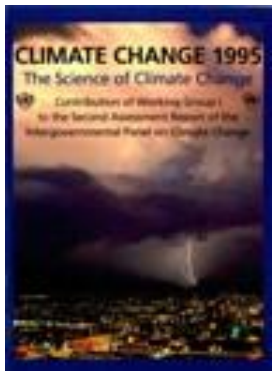
## Worldwide trend, IPCC 2013: +0,85C in last 100 years



1988

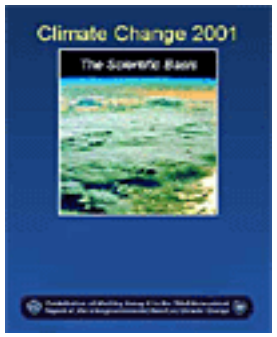

## First assessment report (1990)

- The unequivocal detection of the enhanced greenhouse effect from observations **is not likely** for a decade or more.




## Second assessment report (1995)

- Our ability to quantify the human influence on global climate is currently limited because the expected signal is still emerging from the noise of natural variability… Nevertheless, the ***balance of evidence*** suggests that there is a discernible human influence on global climate.

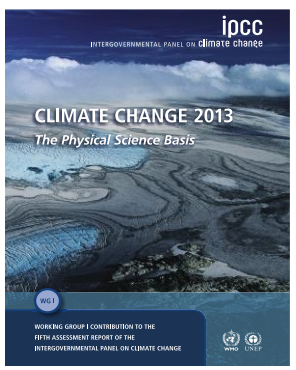



## Third assessment report (2001)

- Most of the observed warming over the last 50 years is ***likely*** to have been due to the increase in greenhouse gas concentrations.


## Fourth assessment report (2007)

- Most of the observed increase in global average temperatures since the mid-20th century is ***very likely*** due to the observed increase in anthropogenic greenhouse gas concentrations.




## Fifth assessment report (2013)

- It is ***extremely likely*** that human activities have caused more than half of the observed increase in global average surface temperature since 1950.

2020

# Canada's climate is changing

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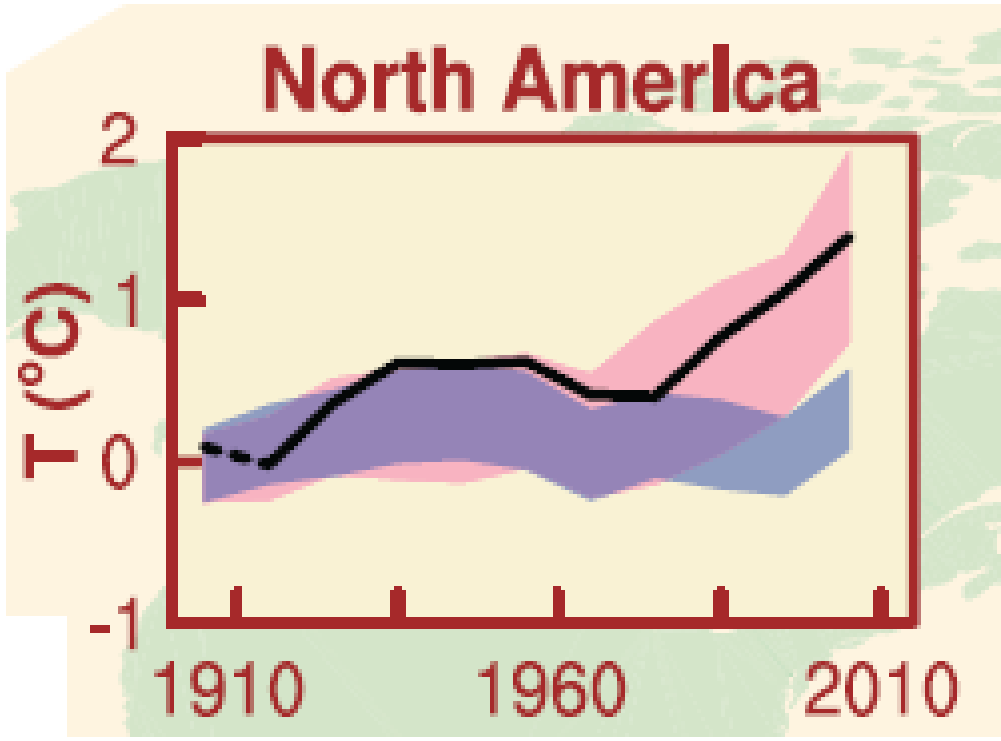
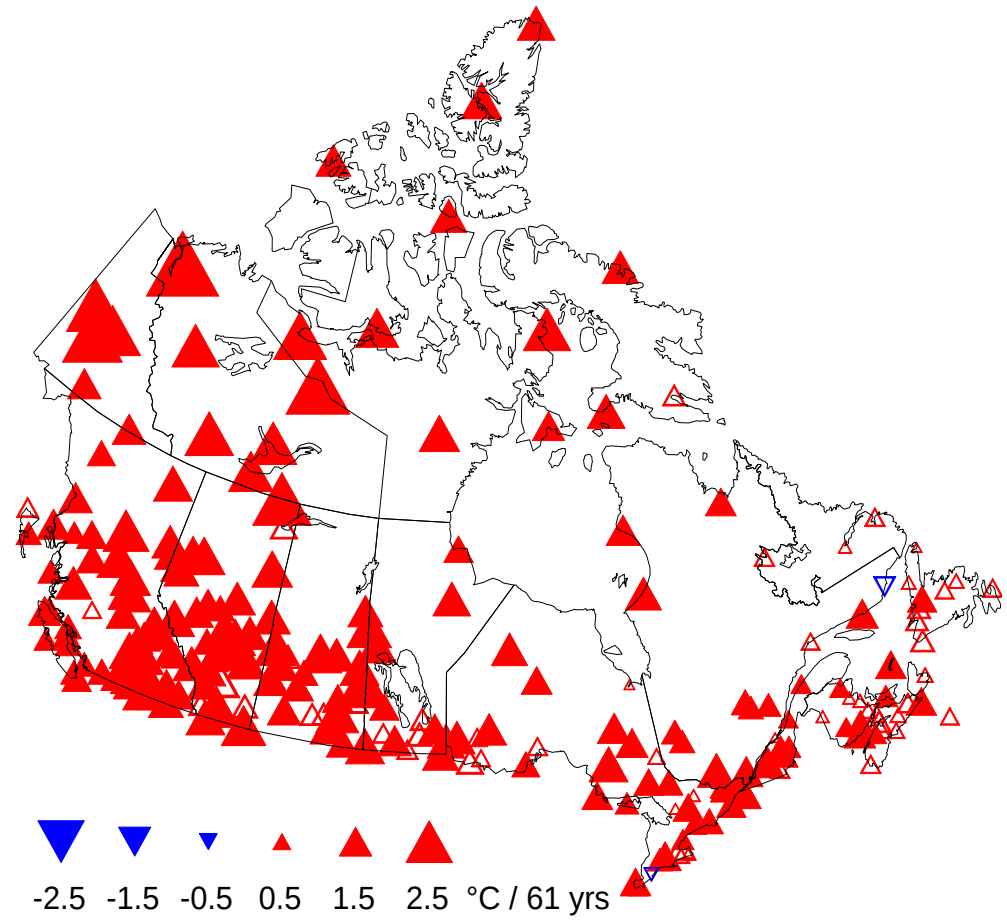
Canada has become warmer (1948-2013):

- Average temperature increased by 1.6° C (2X global)
- In Arctic, average temperature increased by 2.2° C (3X global)




Temperature change with vs without GHG increases
Source: IPCC




***Mean Annual Temperature Trends***

Source: Environment Canada

# Some trends relevant for Canada (1950-2009)

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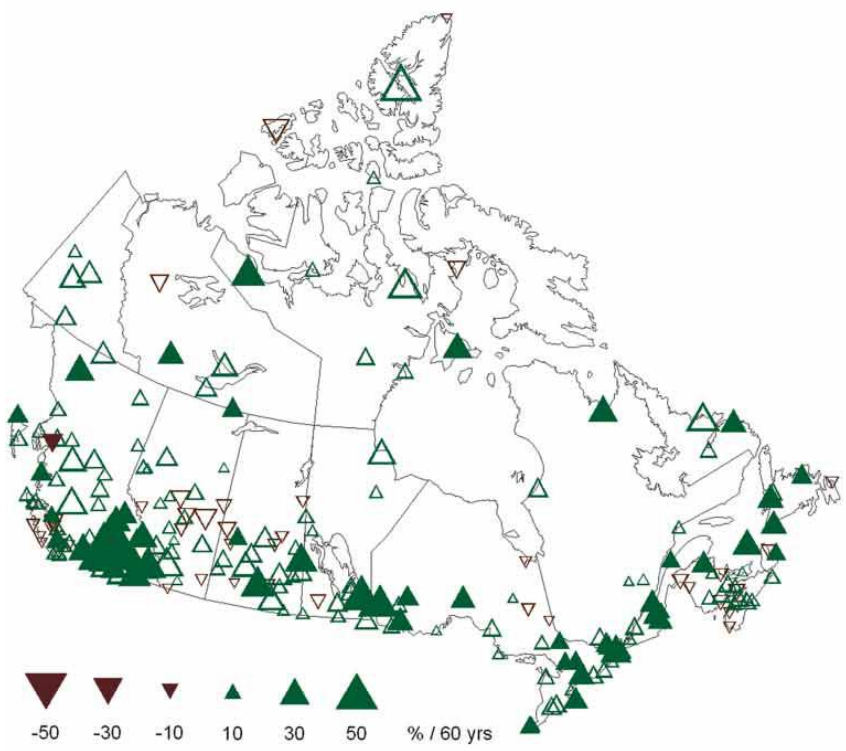
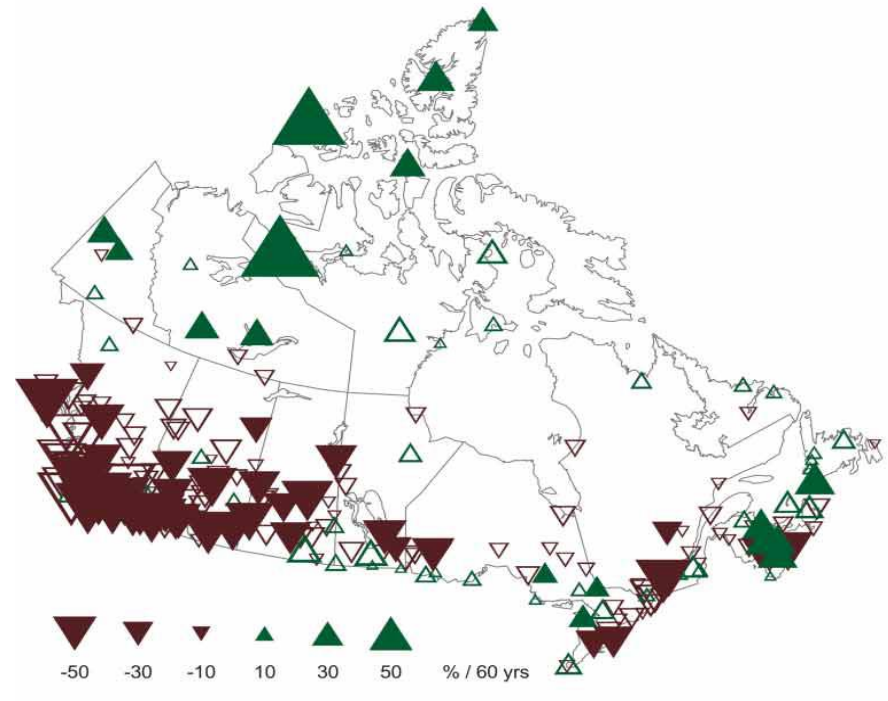
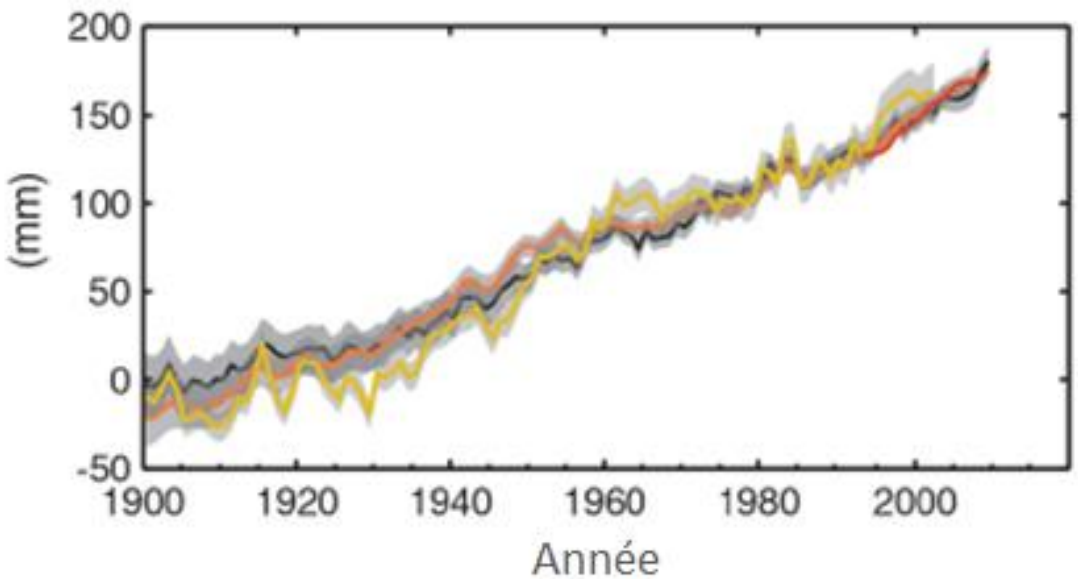



***Annual mean precipitation***



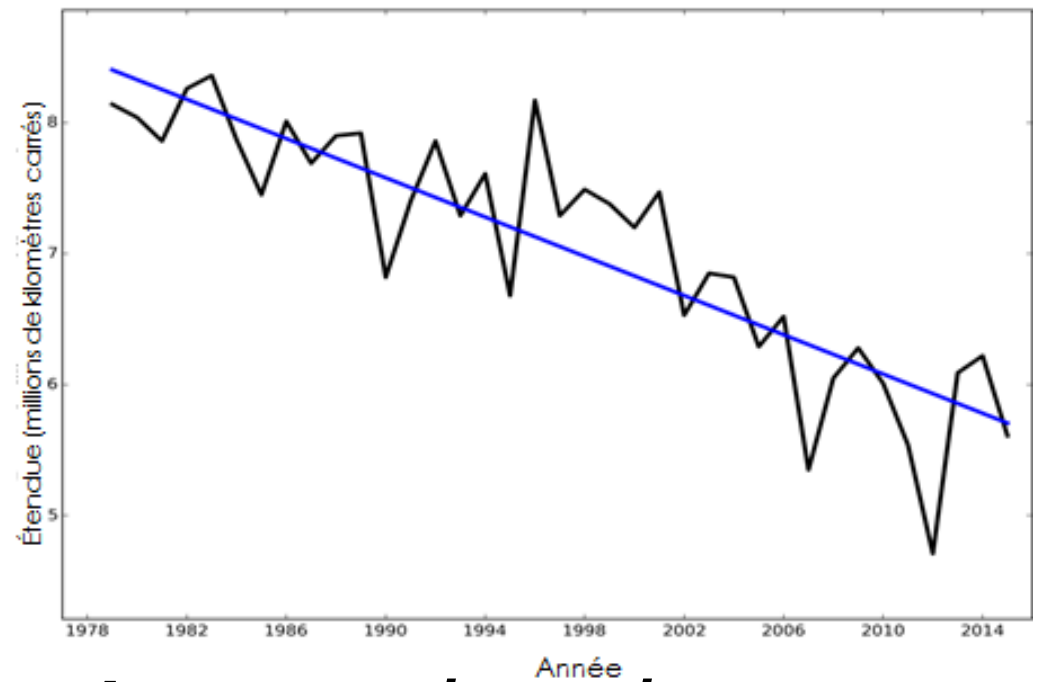

***Annual mean snow***

Vincent & Mekis 2006, 2011




***Global mean sea level (1900-…)***

AR5 du GIEC, Résumé à l'intention des décideurs (GTI), Fig. SPM.3




***August arctic sea ice extent (1979-2015)***

*National Snow and Ice Data Centre*

# Exacerbated regional risks, increasingly on the radar

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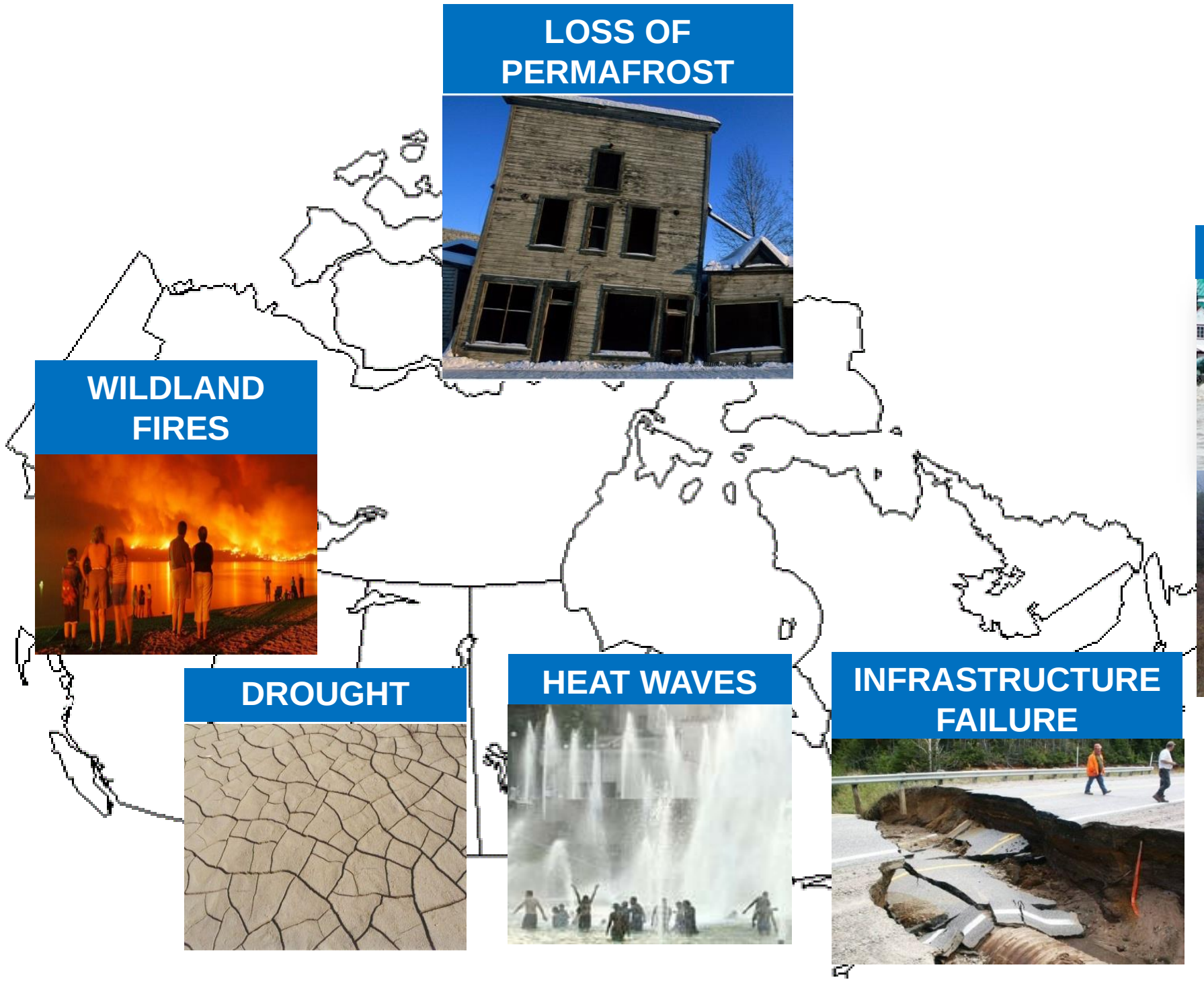
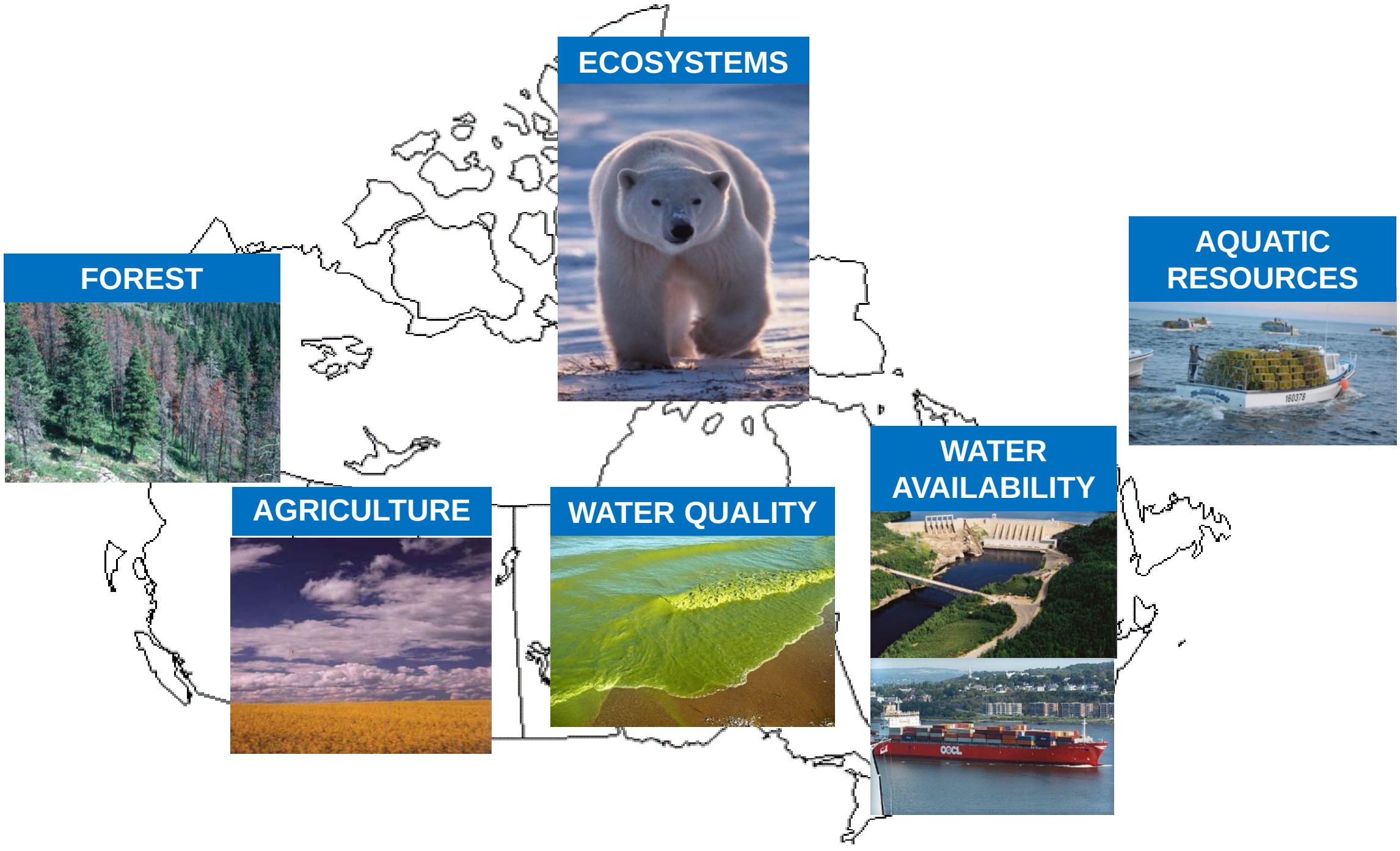



Photos: AP Photo, AlaskaPhotoWorld, F. Prevel/AP

# Variety of longer-term cumulative impacts…

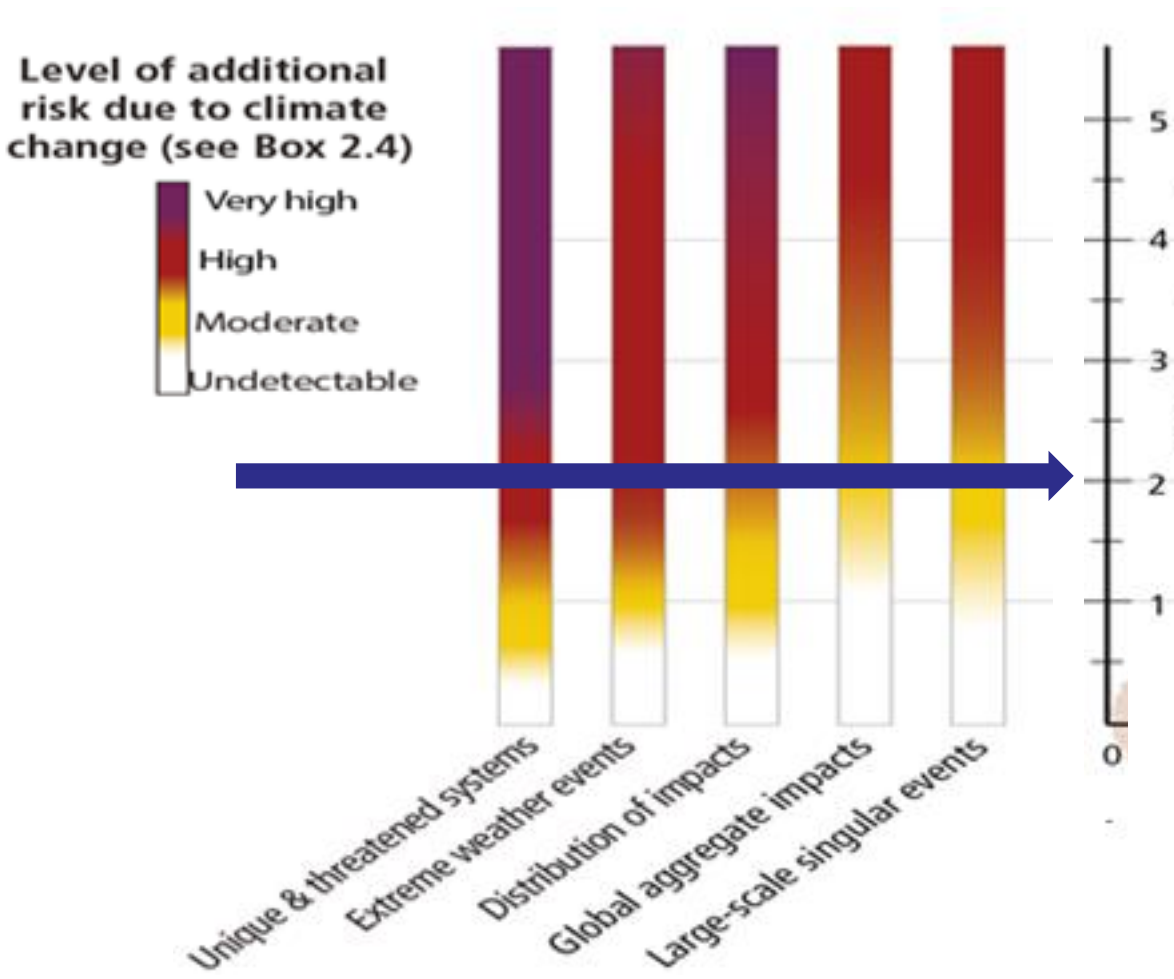





Photos: Parks Canada, T.Archer, Hydro-Quebec, Le Soleil, J-M. Dorion

# Risks from CC depend on cumulative CO2 emissions






Above 2°C, the UNFCCC* target, risks of severe, widespread and irreversible impacts increase.

We are already about 65% of the way to the cumulative emissions limit consistent with 2°C.

*United Nations Framework Convention on Climate Change

Adapted from IPCC, AR5, Synthesis Report, Fig. 3.1

# Keeping CC below 2°C will require rapid ↓ GHG

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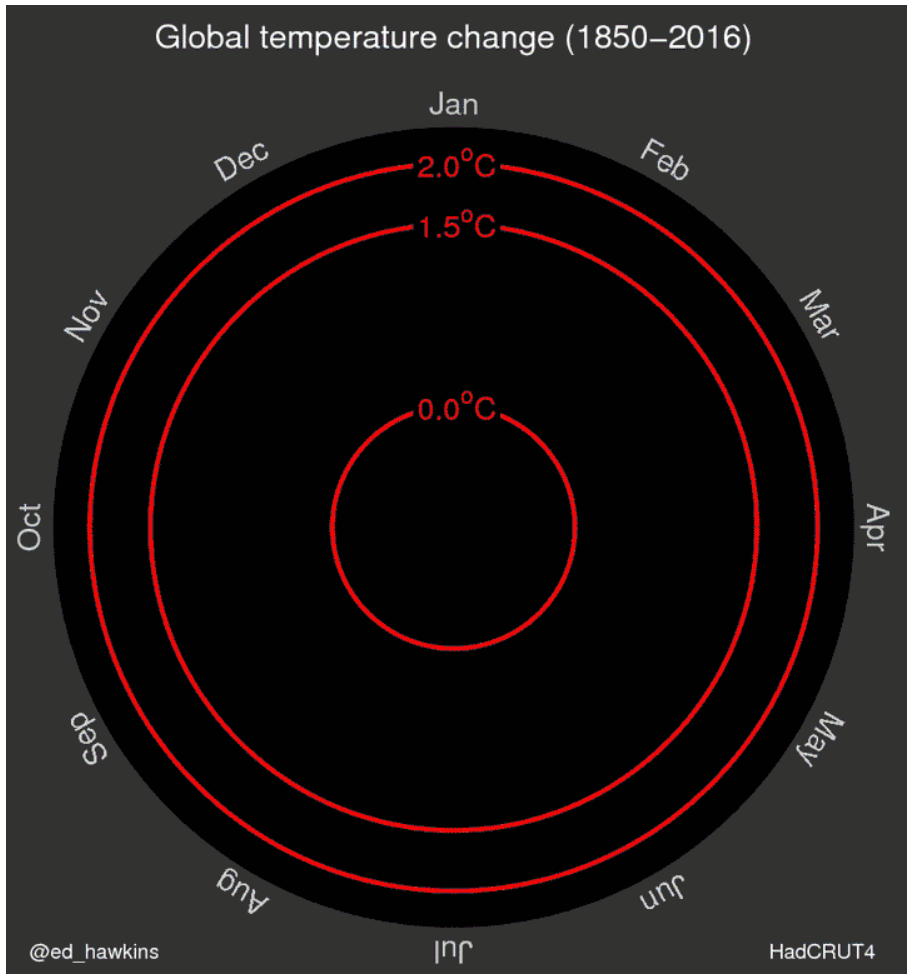
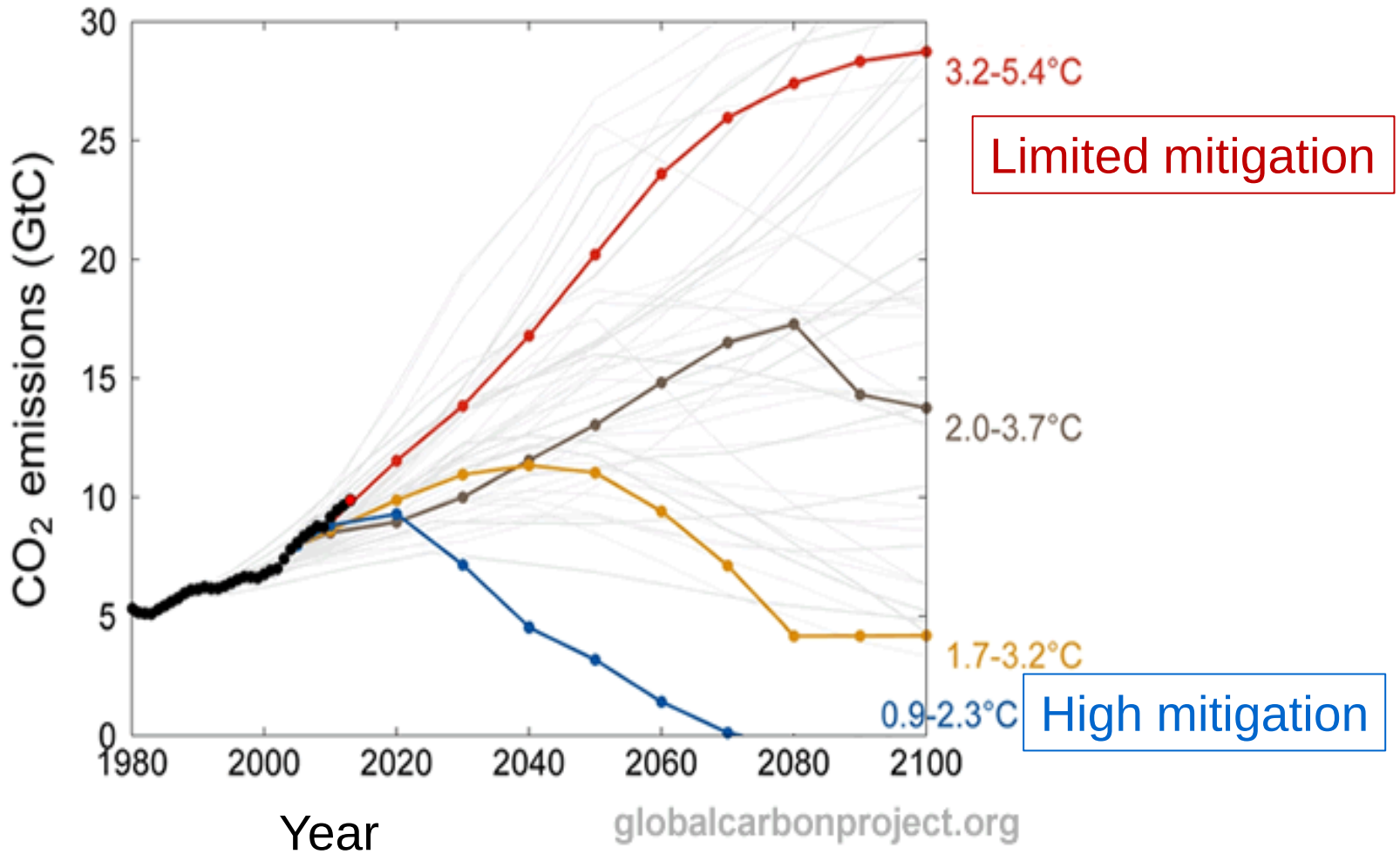



## Observed Emissions and Future Scenarios




The high mitigation scenario is the only one assessed as maintaining temperature change below 2°C. It requires net zero, or even negative, emissions before the end of the century.

IPCC, AR5

# Regional climate scenarios for 2050s (vs 1980s)

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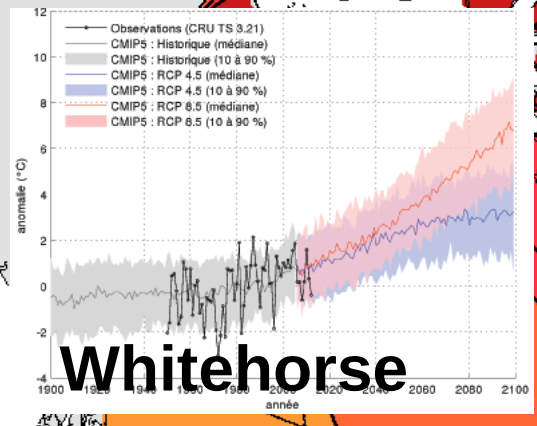
4.5 °C

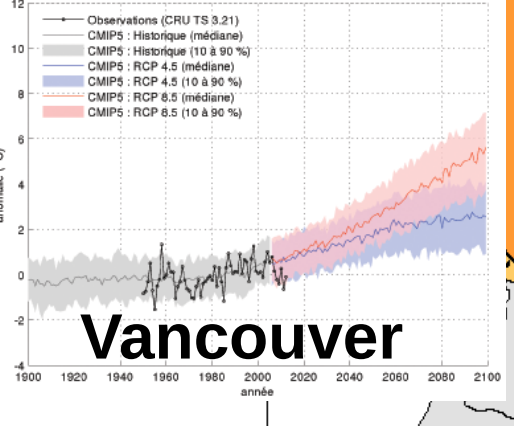
4.0 °C

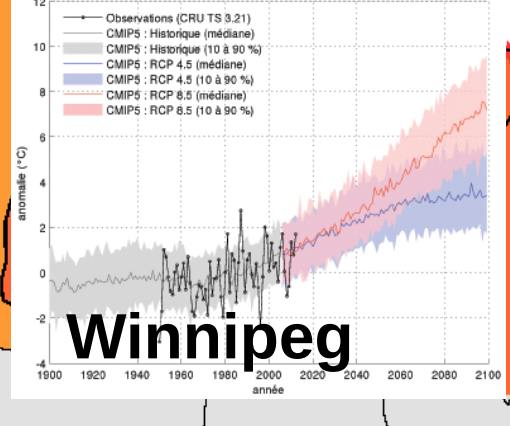
3.5 °C

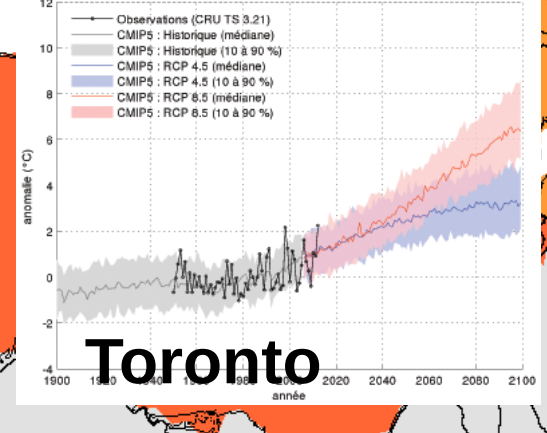
2.5 °C

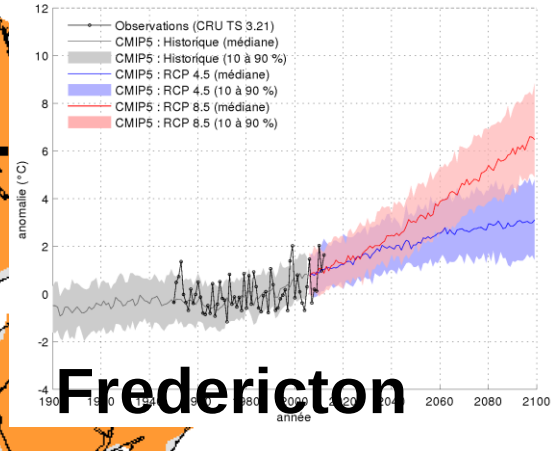
2.5 °C



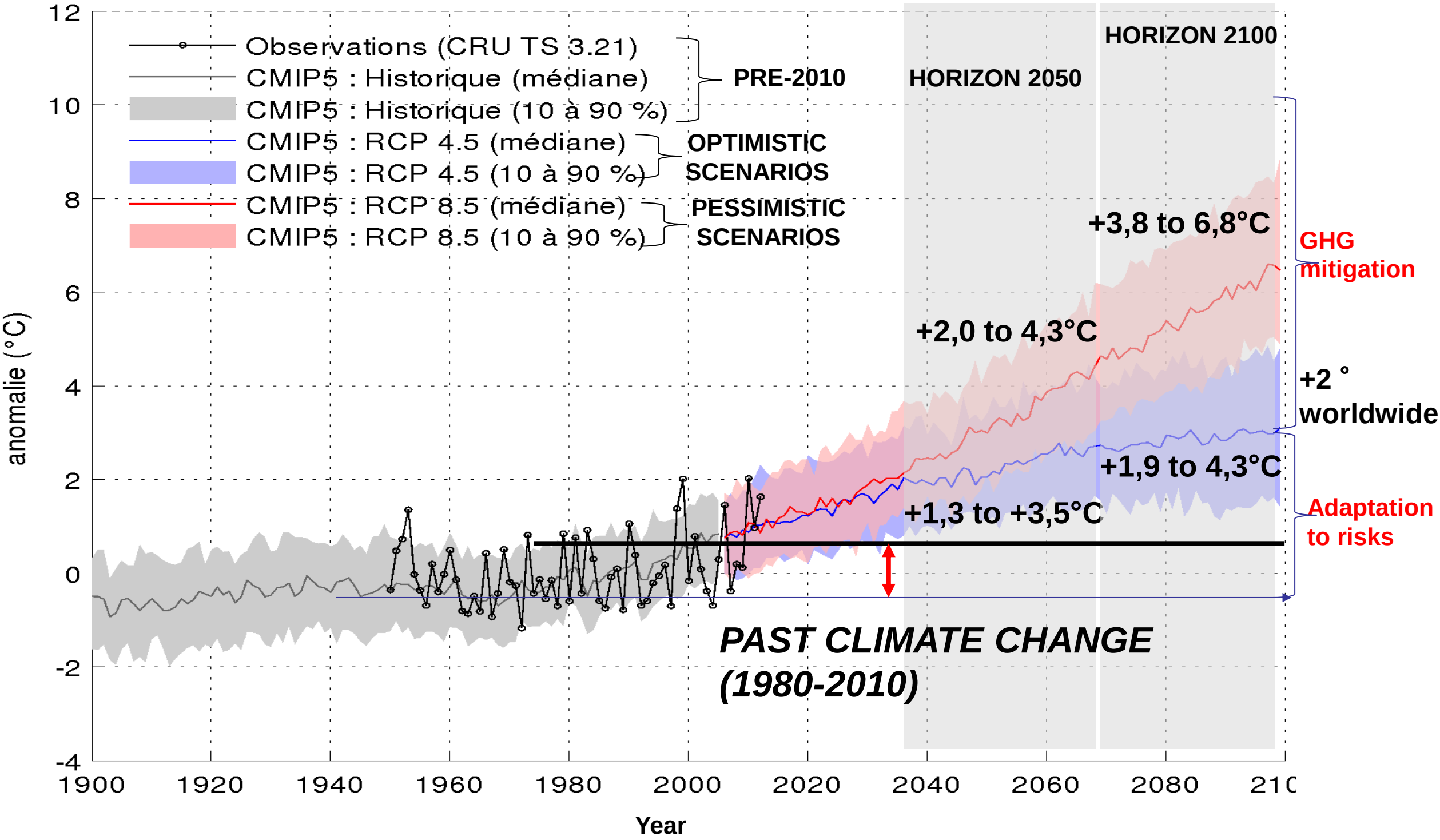




Ouranos, 2015

# Trend for temperatures in Fredericton

www.ouranos.ca




Observed annual temperature anomaly trends for Fredericton (1950-2012) and simulated (1900- 2100) compared to 1971-2000 mean, for the past (gray) and the optimistic scenarios RCP4.5 (blue) and pessimistic RCP8.5 (red).

Ouranos, 2016

# Current and projected climate change

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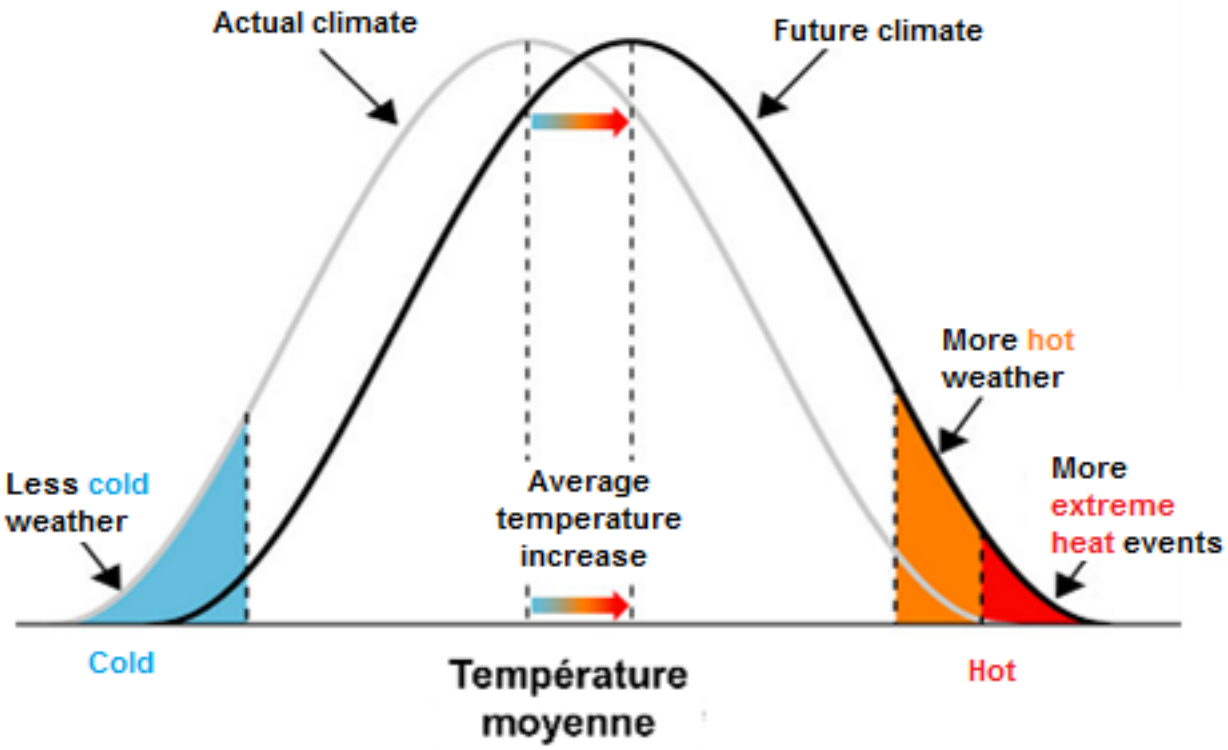
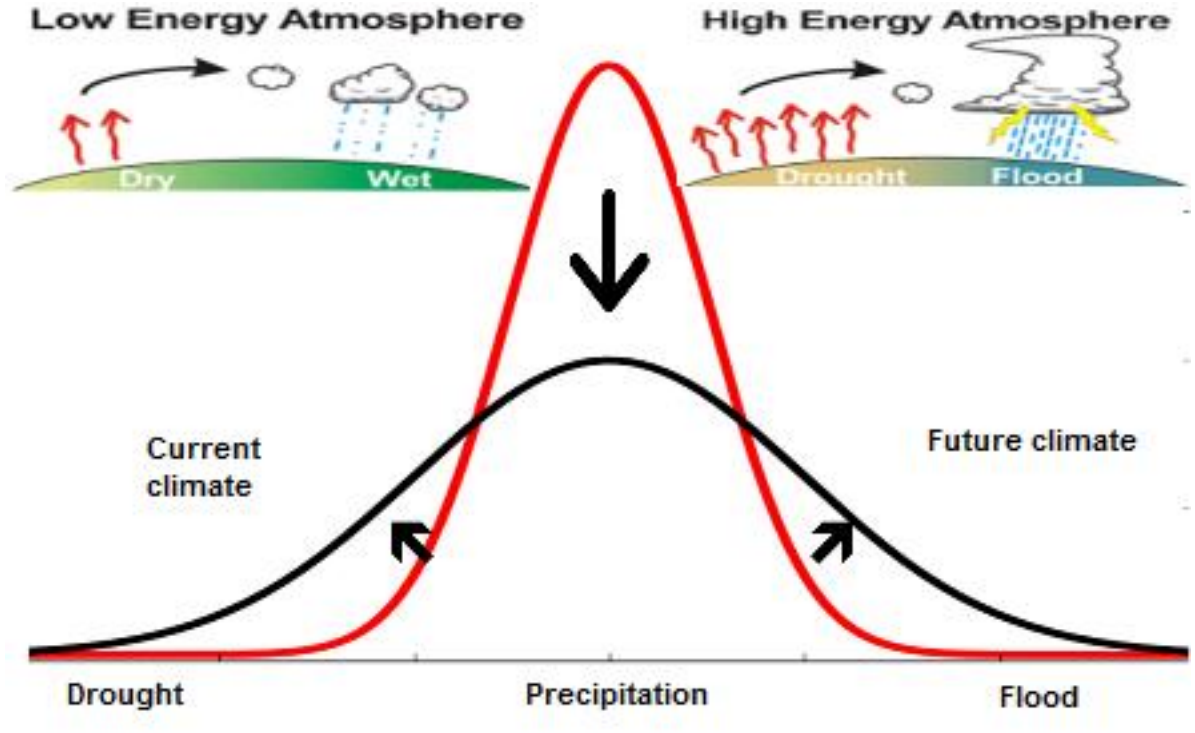
## Temperature




## Water cycle




- Significant higher temperature
- Marked increase of precipitations
- Increased freeze-thaw cycles / thaw

- Arrival increasingly early
- Earlier snow/ice melt

- Risk of major heat wave
- Higher temperature
- "Stormy" precipitations

- Later arrival of the cold season
- Droughts duration up to September
- More intense hurricanes

DJF MAM JJA SON

# Ouranos regional work

www.ouranos.ca

Members

Scientific Council

Board of Directors

Executive director

Administration and Infrastructures

Scientific program

Support to R&D

**CLIMATE SCIENCE**

**CLIMATE SIMULATION AND ANALYSIS**

**CLIMATE SERVICES AND SCENARIOS**

**VULNERABILITIES, IMPACTS & ADAPTATION**

- NORTHERN ENVIRONMENT
- BUILT ENVIRONMENT
- ENERGY
- ECOSYSTEMS AND BIODIVERSITY
- COASTAL ENVIRONMENT
- AGRICULTURE
- FORESTRY
- HEALTH
- WATER MANAGEMENT
- TOURISM

Deputy/Minister

Adjoint Deputy Minister or Director

Contributed manager or coordinnator

Contributed expert/scientist

Driven by an internal capacity to produce relevant climate science connected to university R&D

Driven by a broad network of experts **and** involved « users » lead by an internal capacity to coordinate multidisciplinary programs/projects

**VARIOUS LEVELS OF ENGAGMENT FROM MEMBERS IN CHARGE OF MAINSTREAMING ADAPTATION**

# Risk and opportunities for the energy sector

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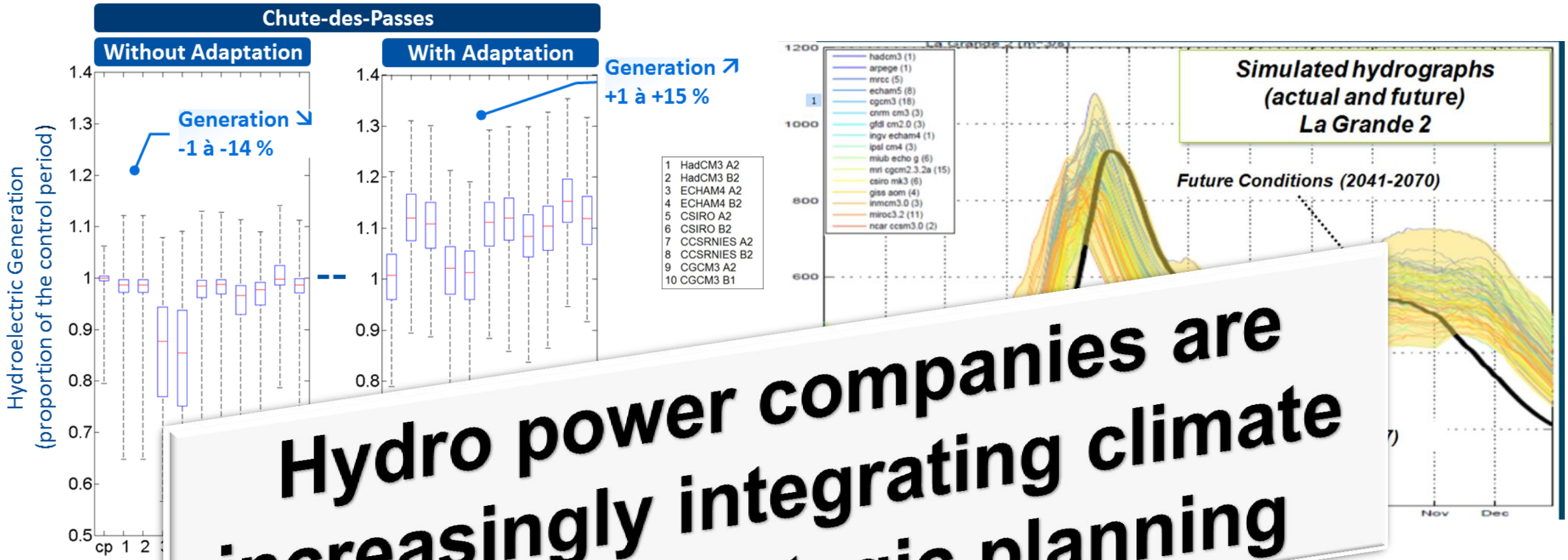
Annual Hydroelectric Generation




**Hydro power companies are increasingly integrating climate change in strategic planning**

| | Chauffage | | Climatisation | | Total électrique | |
|---|---|---|---|---|---|---|
| | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| Commercial | -3,6 | -5,3 | 1,7 | 2,9 | -1,9 | -2,4 |
| Résidentiel | -8,9 | -13,2 | 2,9 | 4,1 | -6,0 | -9,1 |

Lafrance et al, 2015

Région 3: Amérique du Nor

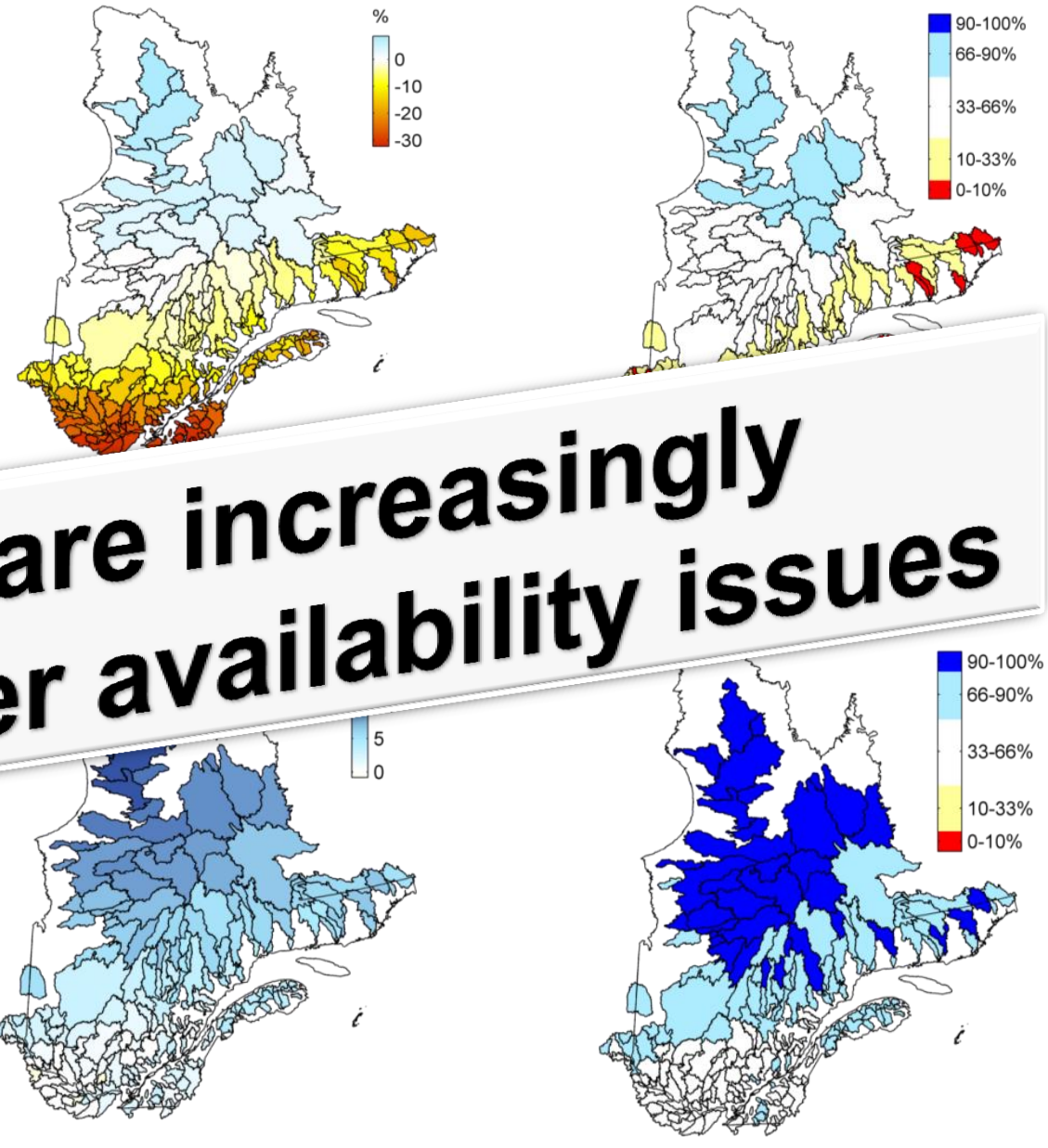
WCRP CORDEX · Hydro Québec · RioTinto · Centre d'expertise hydrique Québec · Ontario Power Generation · Manitoba Hydro

# Managing water resources in southern Quebec

www.ouranos.ca

**Water users are increasingly considering water availability issues**

Change in maximum snow accumulation




**PAST TRENDS (15 YEARS) ARE COHERENT WITH ANTICIPATED RISKS**

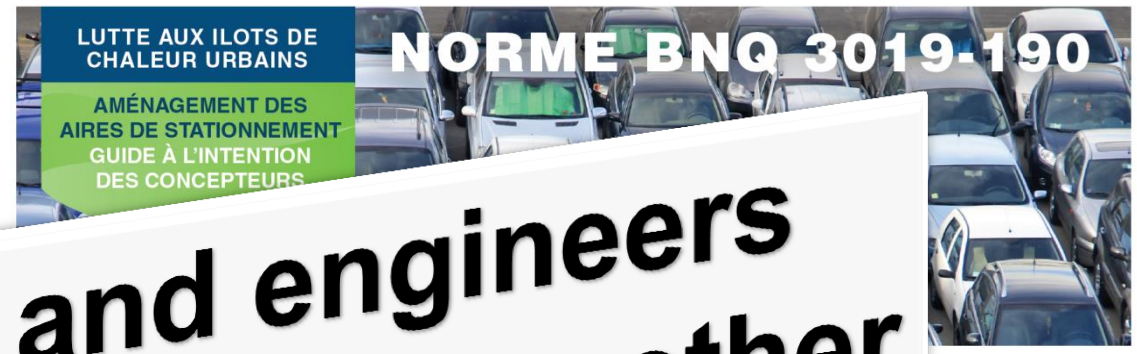
# Integrated perspective for municipal infrastructures

www.ouranos.ca



BNQ
Bureau de normalisation du Québec

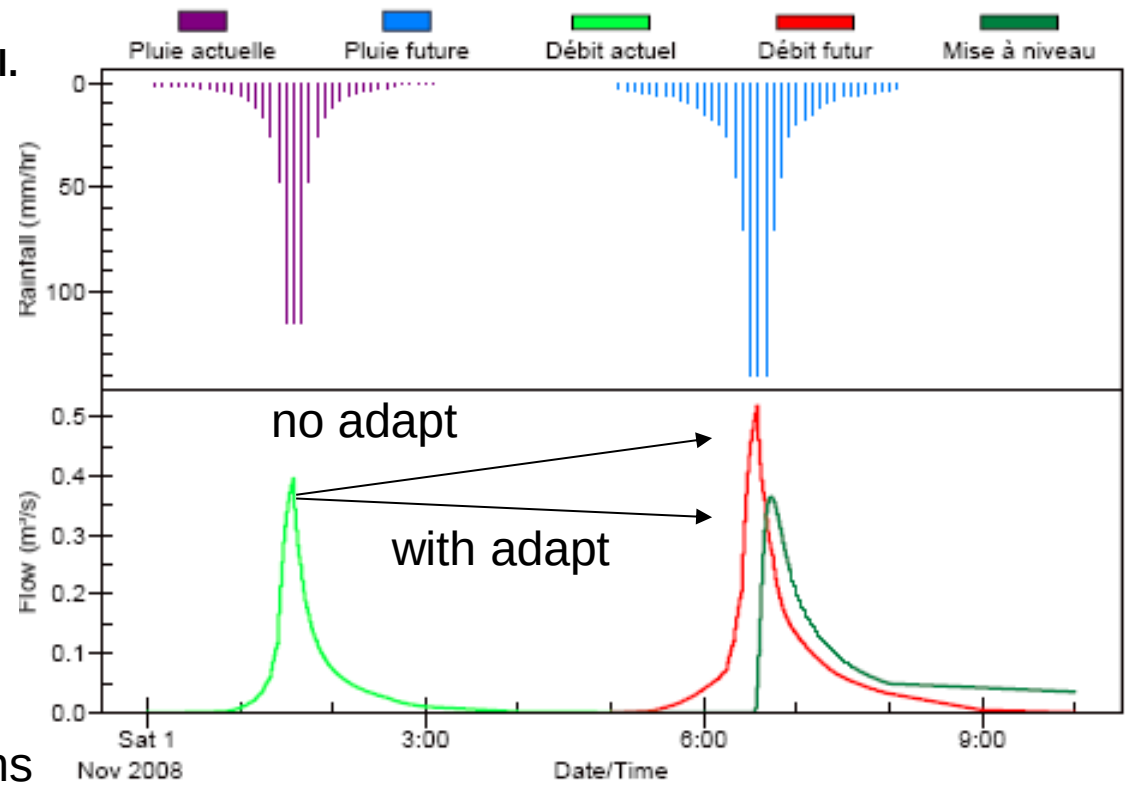
DOCUMENT SYNTHÈSE




**Land use planners and engineers decreasing risks by working together**


Mailhot et al.

Optimisation of adaptation options

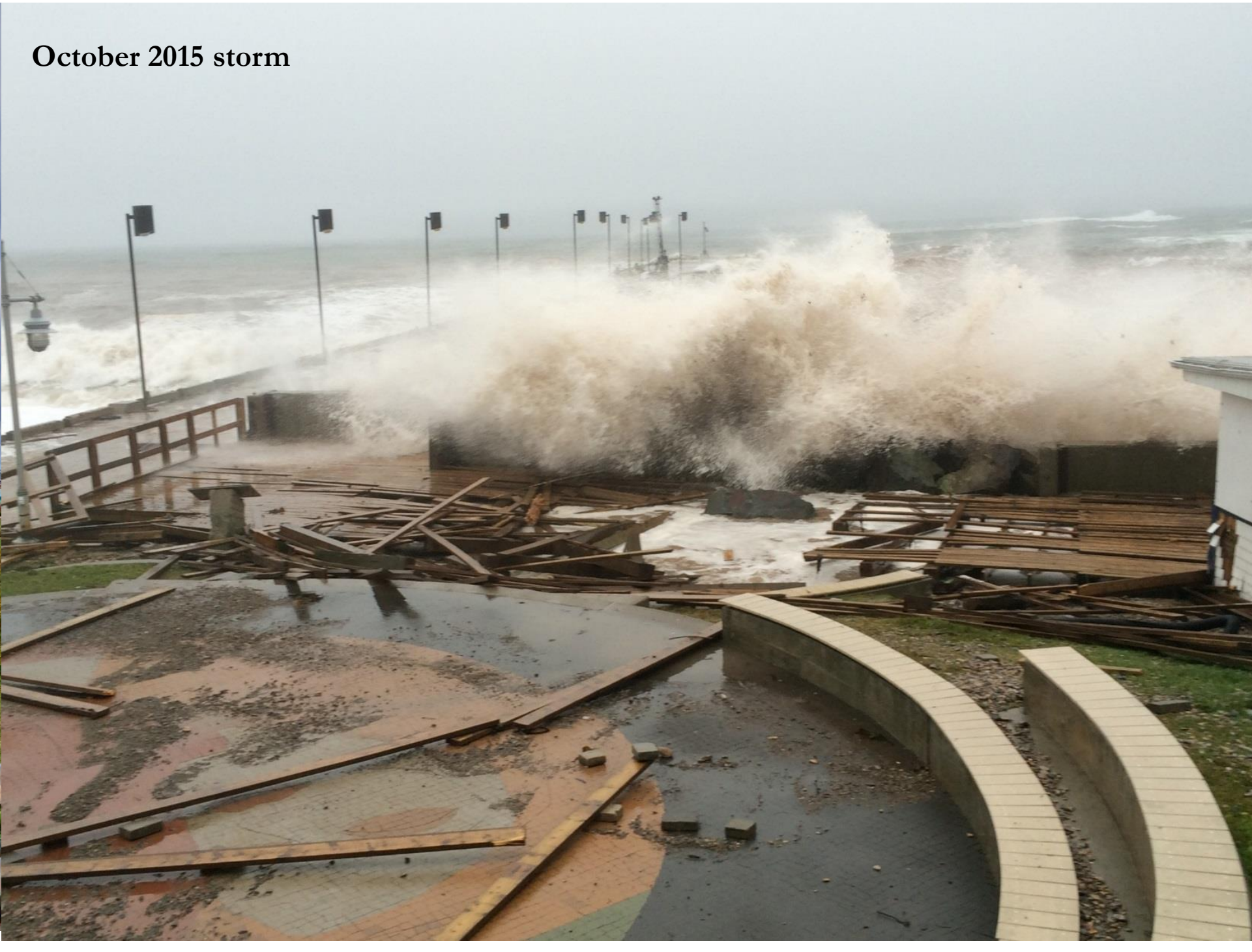



## DRAINAGE AND URBAN HEAT


# IMPACTS OF CLIMATE CHANGE IN COASTAL ZONE

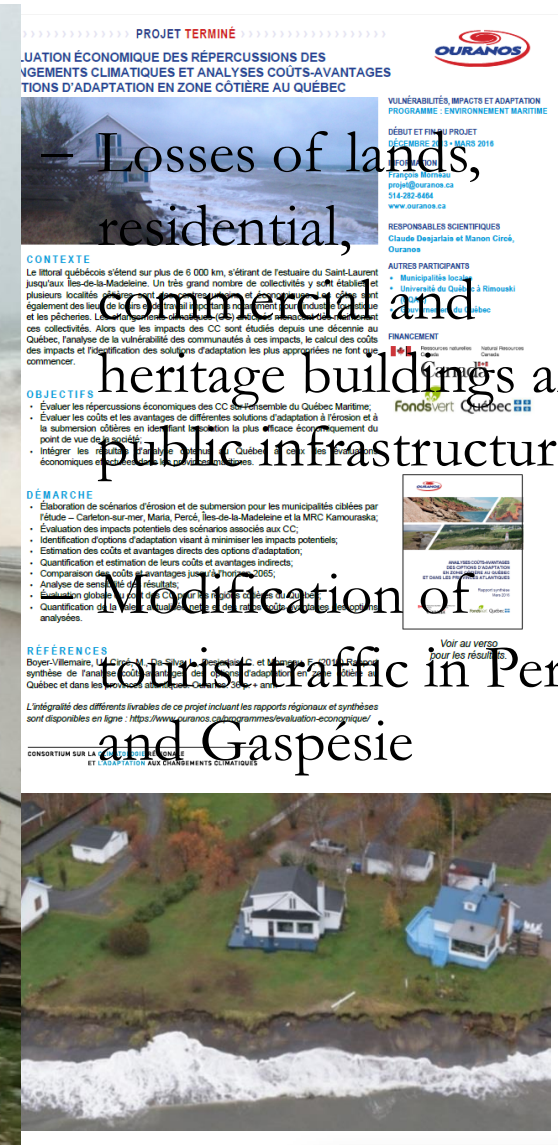
www.ouranos.ca

October 2015 storm



– Losses of lands, residential, commercial and heritage buildings and public infrastructure

– Modification of tourist traffic in Percé and Gaspésie


PROJET TERMINÉ

LUATION ÉCONOMIQUE DES RÉPERCUSSIONS DES
NGEMENTS CLIMATIQUES ET ANALYSES COÛTS-AVANTAGES
TIONS D'ADAPTATION EN ZONE CÔTIÈRE AU QUÉBEC

VULNÉRABILITÉS, IMPACTS ET ADAPTATION
PROGRAMME : ENVIRONNEMENT MARITIME

CONTEXTE

OBJECTIFS

DÉMARCHE

RÉFÉRENCES

Voir au verso pour les résultats.

L'intégralité des différents livrables de ce projet incluant les rapports régionaux et synthèses sont disponibles en ligne : https://www.ouranos.ca/programmes/evaluation-economique/



# ADAPTATION SOLUTIONS INTEGRATING CC

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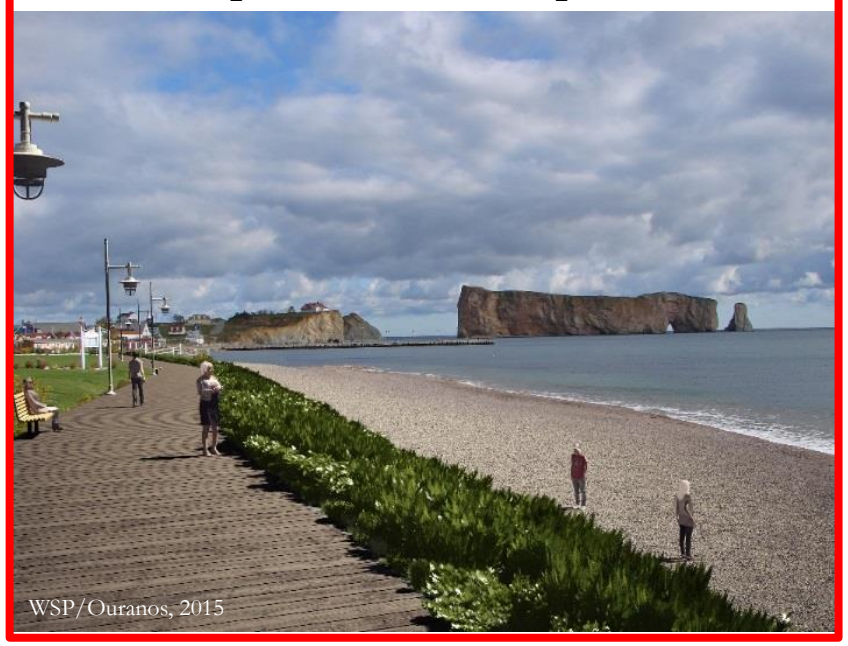
**1. Beach replenishment with pebbles**




**2. Beach replenishment with pebbles and T groynes**


**3. Riprap**


**4. Rubblemont revetment**


**5. Concret seawall with deflector**


- 1$ invested = 68$ in gain
- Back to a natural coast
- Protection against storm surges and erosion
- Improving access to the sea for tourists
- Landscape improvement
- Increased tourist traffic in Gaspésie by 2% (35 000 overnight stays/year)

UQAR

OURANOS

Fondsvert Québec

Ressources naturelles Canada / Natural Resources Canada

Canada

# TOWARDS A REGIONAL STRATEGY ON COASTAL MANAGEMENT UNDER A CHANGING CLIMATE

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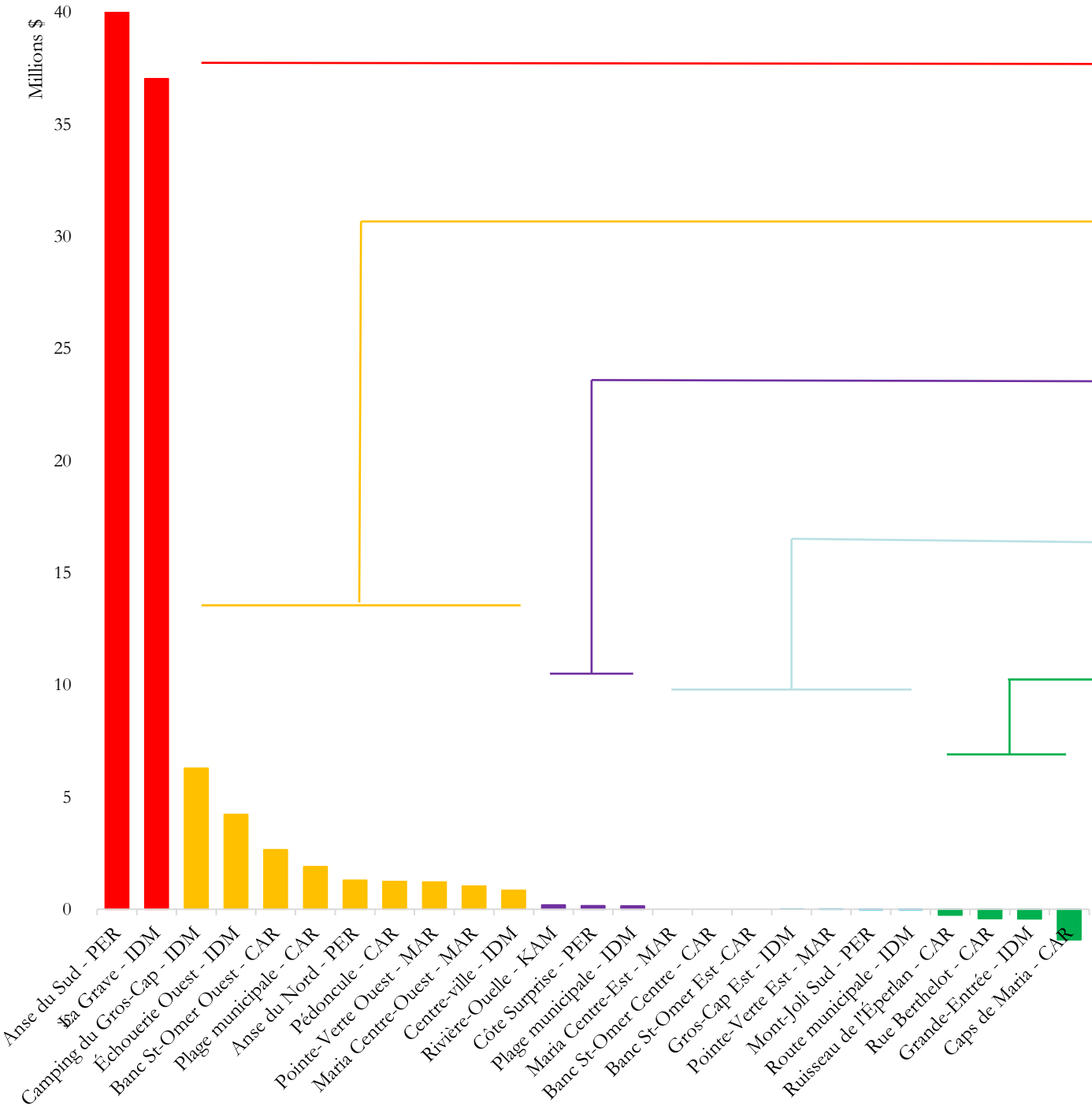


**Non-intervention is not an option**

Regional touristic attraction

**Net advantage to intervene**

High expected losses ranging between $ 1 and $ 15 million

**Small advantage to intervene**

One important local asset at risk

**Within a margin of $25,000**

Low anticipated damages only justifying prevention measures

**No net advantage to intervene**

Segment sparsely built with long-term damage expected

TOWARDS A REGIONAL COASTAL MANAGEMENT STRATEGY UNDER A CHANGING CLIMATE

# Adapting to increased risks for population health

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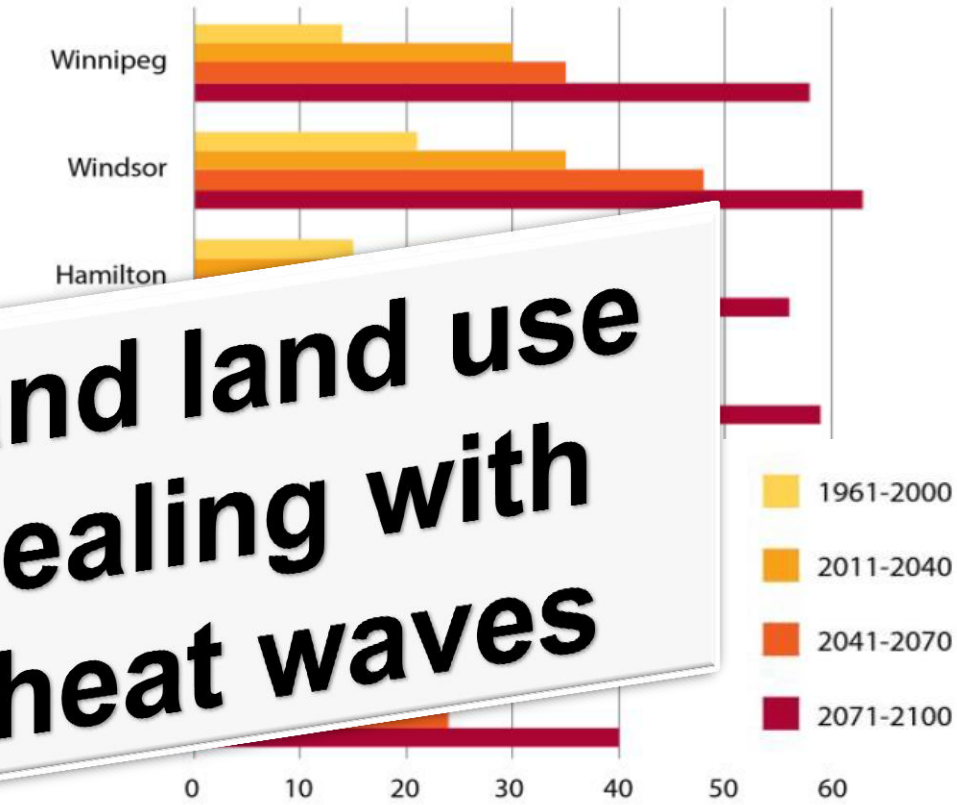
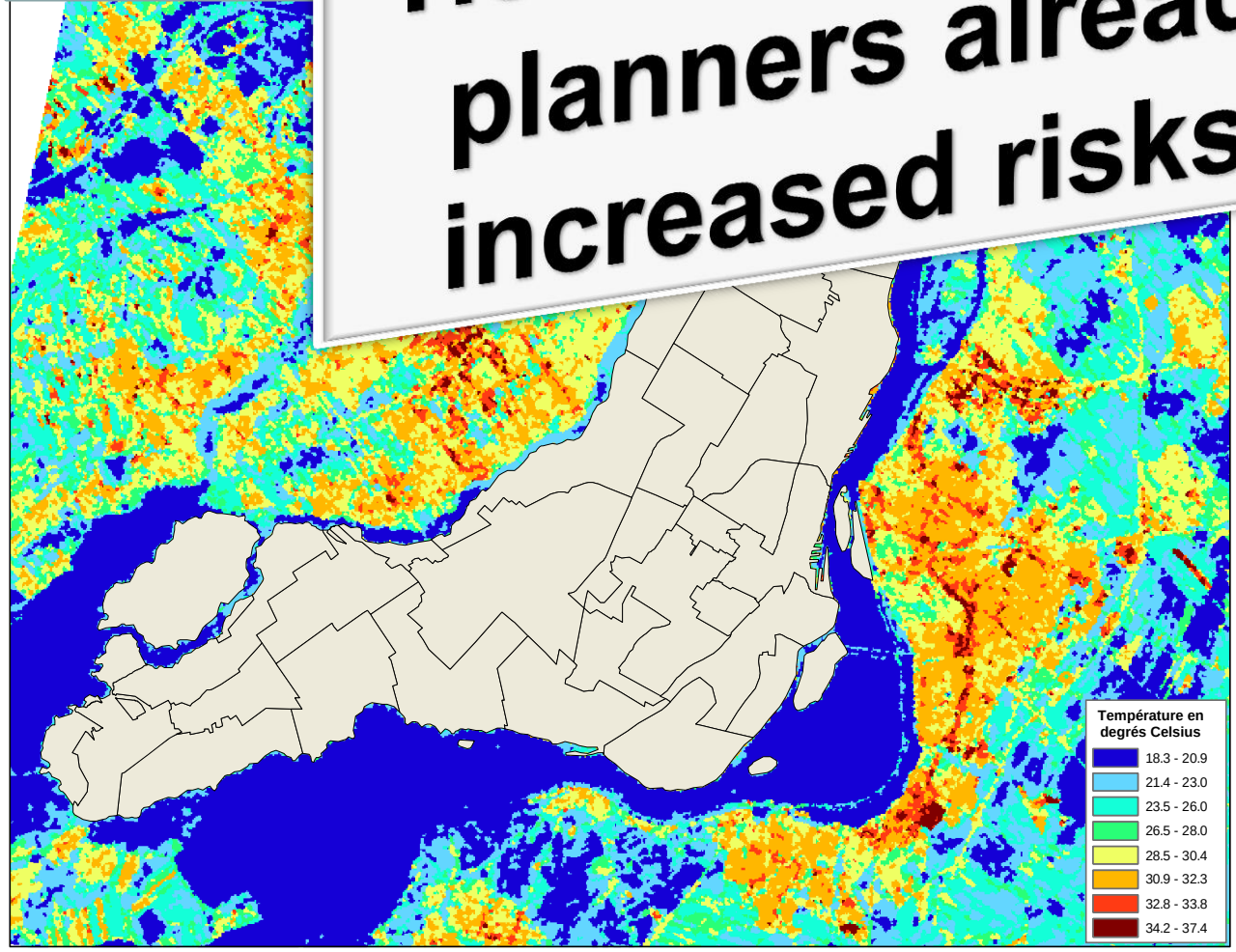
## NUMBER OF HOT DAYS(>30°C)

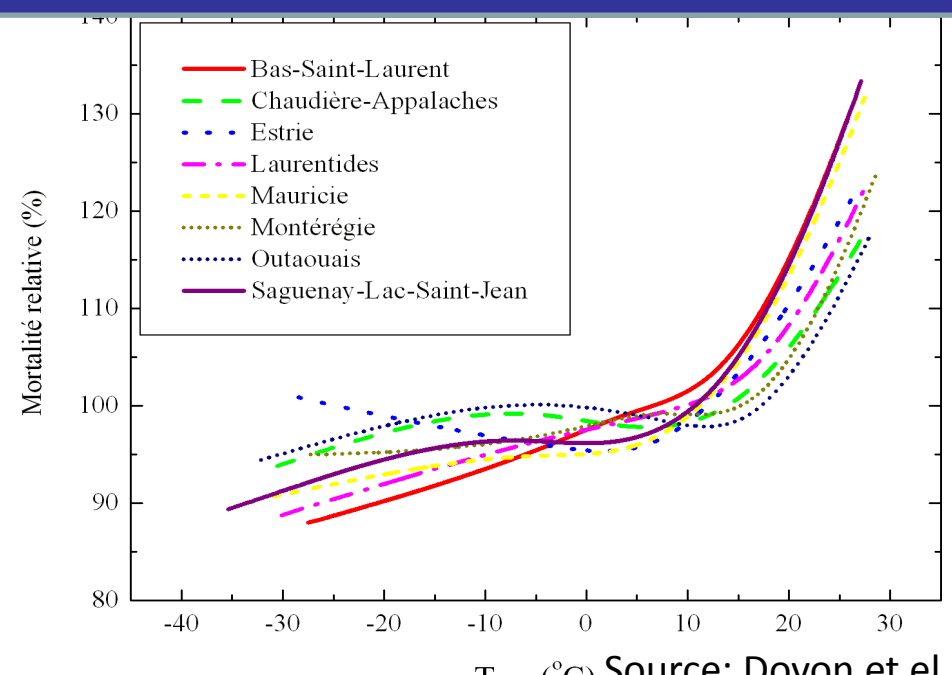



Source: Casati et al (2013)

**Health specialists and land use planners already dealing with increased risks of heat waves**




## TEMPERATURE AND MORBIDITY



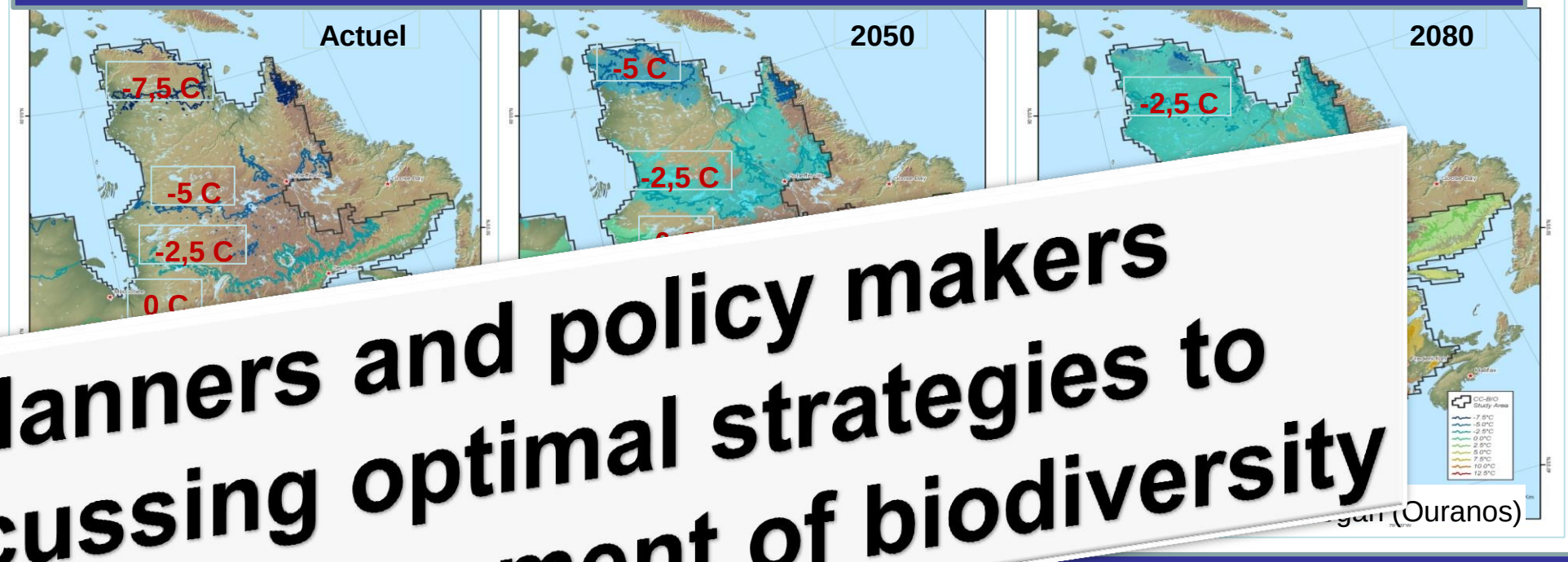

Source: Doyon et el

# Facilitate the adaptation of natural environment

**Planners and policy makers discussing optimal strategies to facilitate displacement of biodiversity**

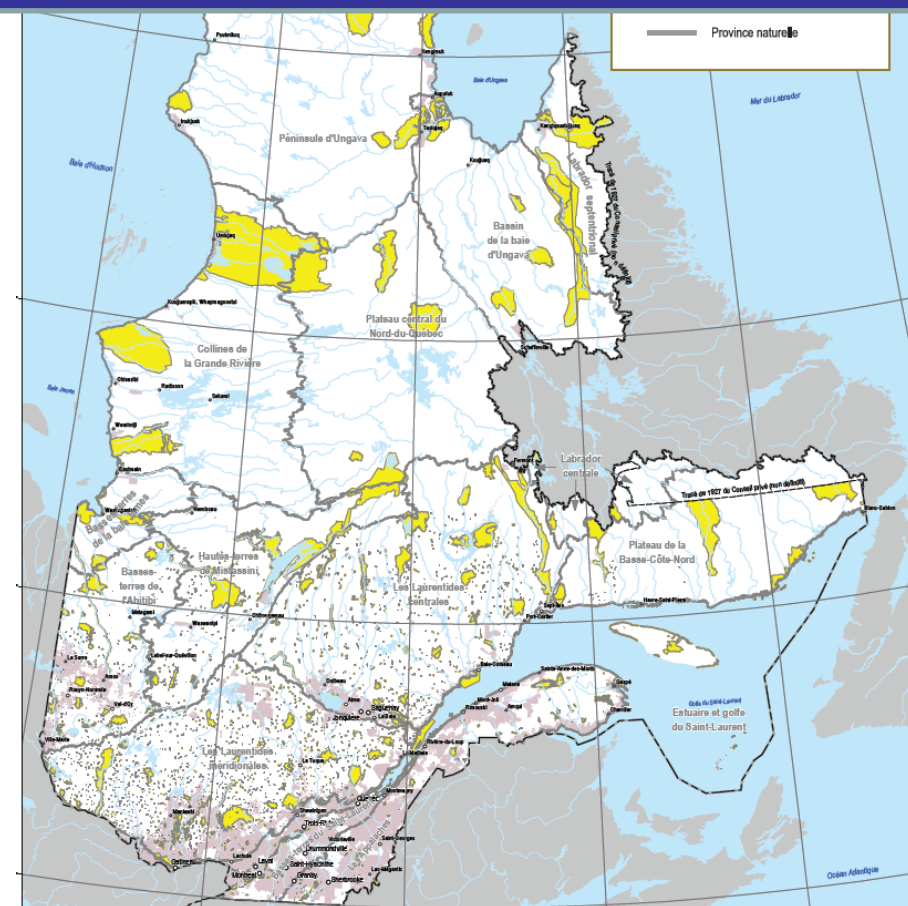
www.ouranos.ca

## ISOTHERMS TRENDS



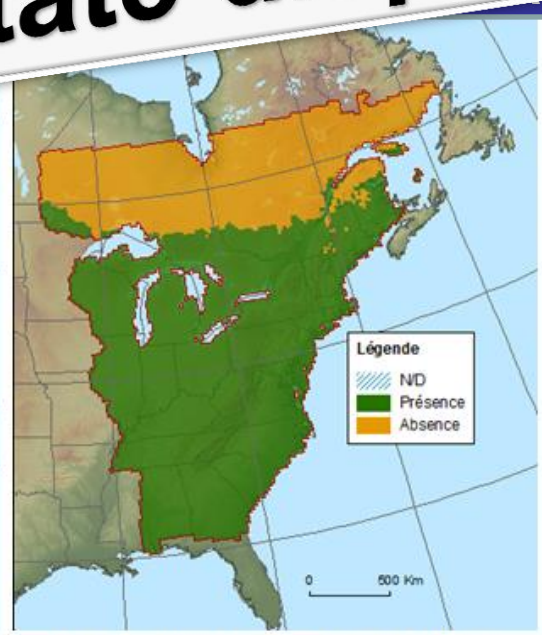

gan (Ouranos)

## NETWORK OF PROTECTED AREAS

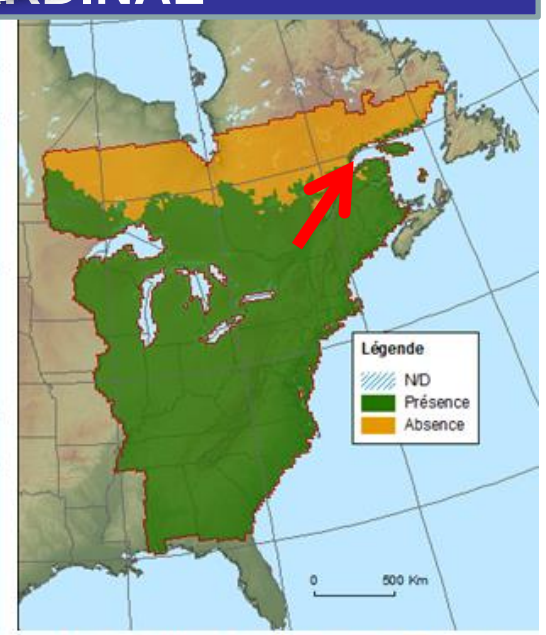



## CARDINAL


Répartition observée du Cardinal pour 1961-1990




Niche climatique favorable à l'espèce projetée pour 2041-2070




Niche climatique favorable à l'espèce projetée pour 2071-2100

Source: Projet CCBio de D. Berteaux, UQAR (2011)

# Climate Change and Tourism Industry

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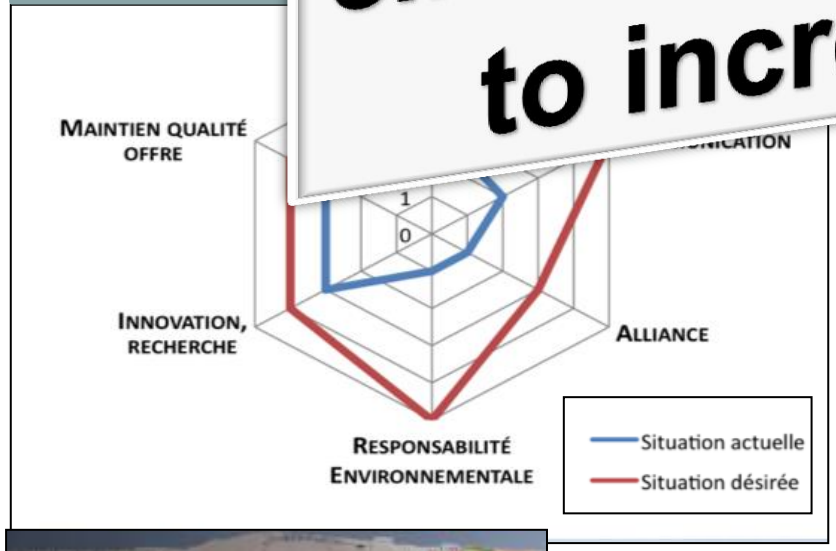
## CHANGES TO SNOW ACCUMULATION


Membres différents du modèle couplé global MCCG3 selon le scénario d'émissions de GES SRES A2

**Industries reacting to new climatic constraints/opportunities to increase competitiveness**

## ADAPTA




CHAIRE de tourisme Transat
ESG UQÀM

## IMPACTS ANALYSIS FOR INDUSTRY

- Analysis of socio-economic impacts and adaptation to climate change by Québec's tourism industry

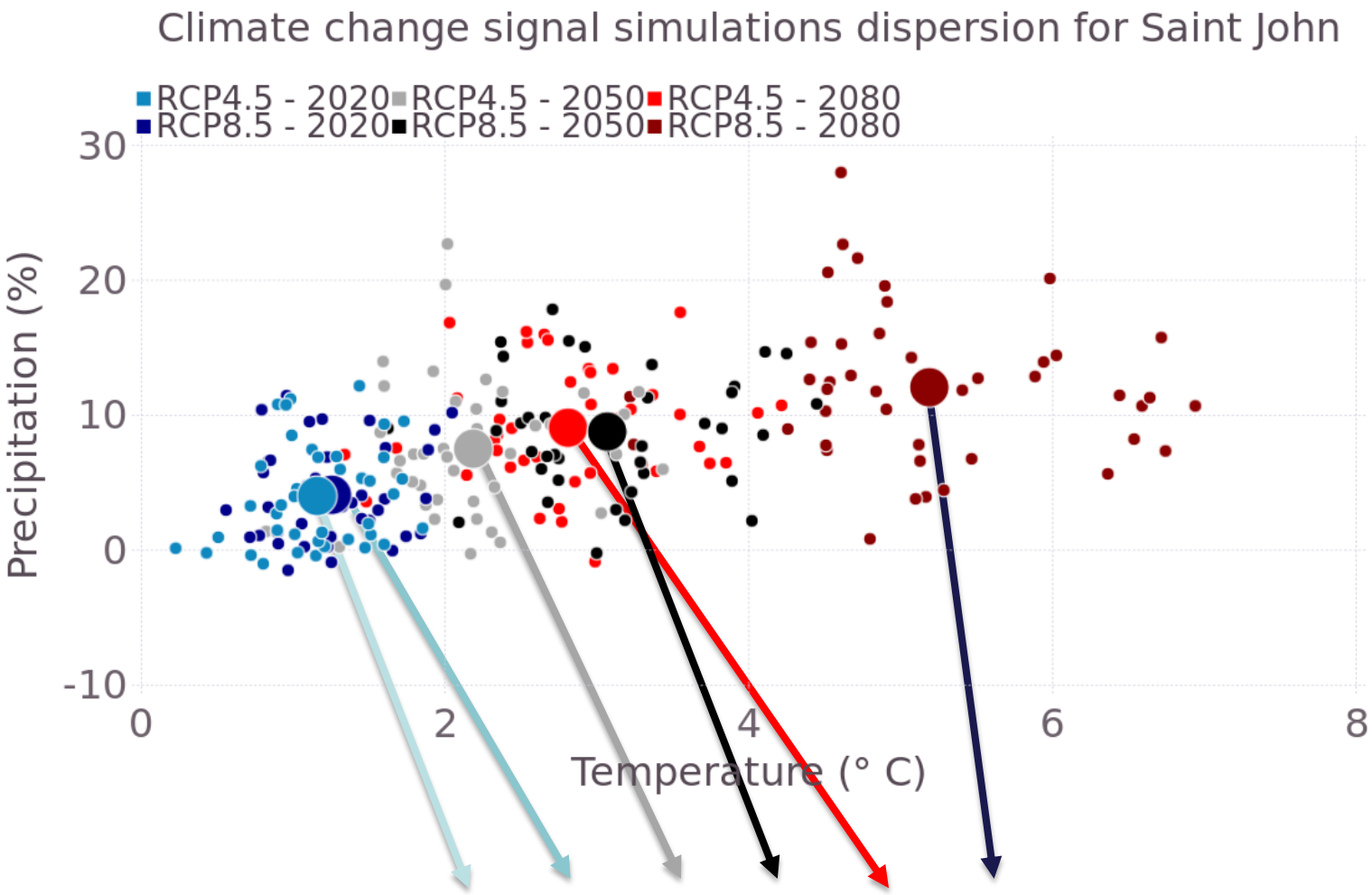
WATERLOO | ENVIRONMENT

Canada

OURANOS · Ressources naturelles Canada / Natural Resources Canada · Canada · Fonds vert · Québec

# Scenarios produced for New Brunswick

www.ouranos.ca




| Temperature | 2020 | 2050 | 2080 |
|---|---|---|---|
| RCP 4,5 | +1,2°C | +2,2°C | +2,8°C |
| RCP 8,5 | +1,3°C | +3,1°C | +5,2°C |

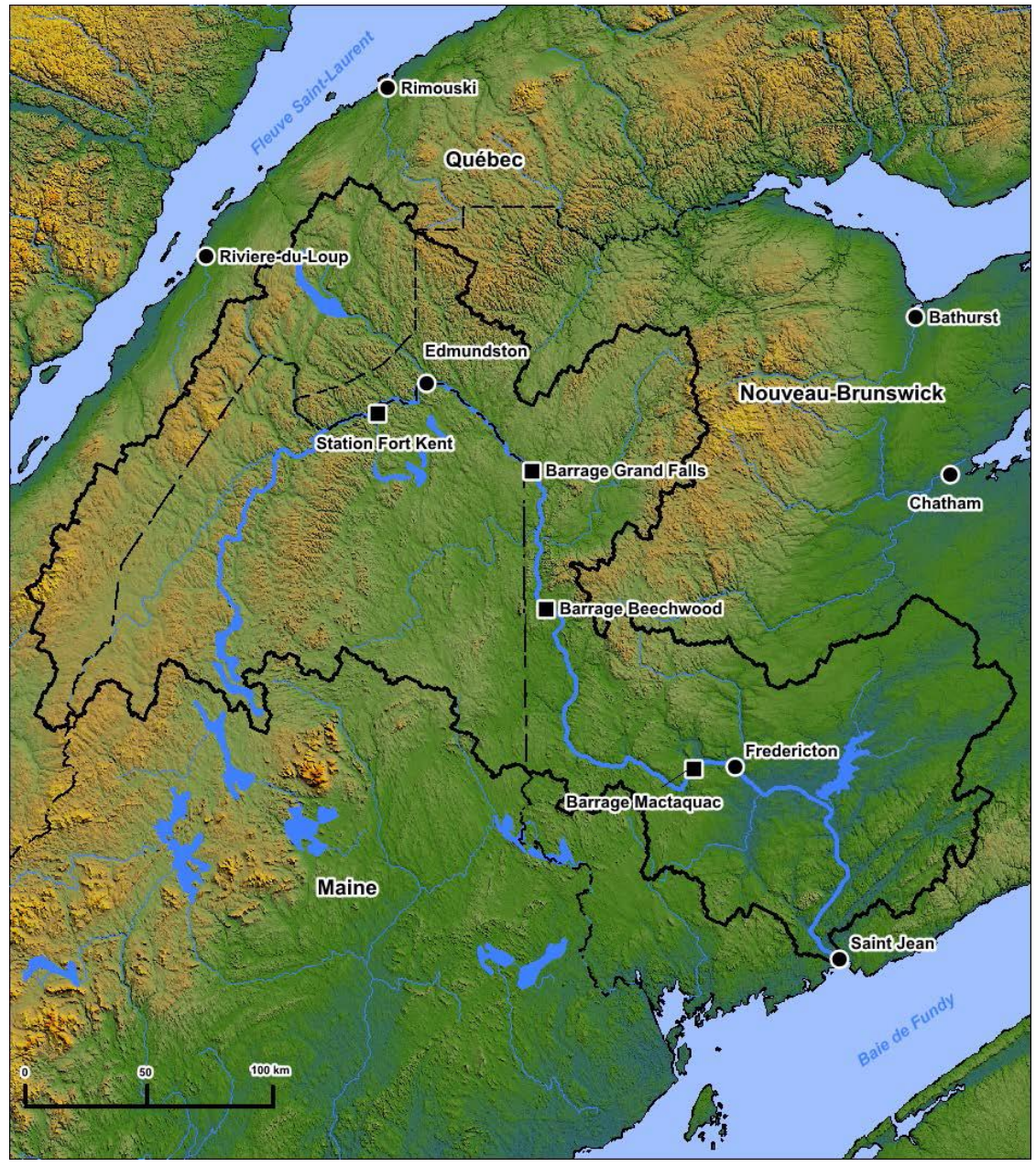
| Annual Precipitation | | | |
|---|---|---|---|
| RCP 4,5 | +4% | +8% | +9% |
| RCP 8,5 | +4% | +9% | +12% |

| | Variables of interest |
|---|---|
| 1 | Mean Temperature |
| 2 | Winter Mean Temperature |
| 3 | Spring Mean Temperature |
| 4 | Summer Mean Temperature |
| 5 | Autumn Mean Temperature |
| 6 | Annual Total Precipitation |
| 7 | Winter Total Precipitation |
| 8 | Spring Total Precipitation |
| 9 | Summer Total Precipitation |
| 10 | Autumn Total Precipitation |
| 11 | Annual Number of Days with Maximum Temperature >25°C |
| 12 | Annual Number of Days with Maximum Temperature >30°C |
| 13 | Annual Number of Days with Maximum Temperature >35°C |
| 14 | Annual Number of Days with Maximum Temperature <0°C |
| 15 | Annual Number of Days with Maximum Temperature <-10°C |
| 16 | Annual Number of Days with Maximum Temperature <-20°C |
| 17 | Annual Cooling Degree Days |
| 18 | Annual Heating Degree Days |
| 19 | Annual Corn Heat Units |
| 20 | Annual Freeze-Thaw Days |
| 21 | Spring Freeze-Thaw Days |
| 22 | Autumn Freeze-Thaw Days |
| 23 | Winter Freeze-Thaw Days |
| 24 | Growing Season Length |
| 25 | Annual Total Rain Days |
| 26 | Annual Total Snow Days |
| 27 | Freeze-Free days |
| 28 | Annual Growing Degree Days >10°C |
| 29 | Annual Growing Degree Days >5°C |

# Projects completed for New Brunswick



1. Saint John River Basin Probable Maximum Flood
2. Saint John River Basin Hydrology
3. New Brunswick Electric Load Forecast
4. General NB Power Needs
5. NB Government Needs
6. Canadian Rivers Institute Mactaquac Aquatic Ecosystem Studies




Saint John River watershed

# Science basic advice to Governments

www.ouranos.ca

## A COMPLEMENTARY APPROACH

**INTERNATIONAL COMMITMENTS**

**REGIONAL NEEDS**

**REDUCE**
greenhouse gases

**ADAPT**
to changes

**AVOID**
3 - 4 X $CO_2$

**PREPARE**
2 X $CO_2$

## Manage GHG

Canada (2012)

**Oil and gas = 25%**
**Transportation = 24%**
**Electricity = 12%**
**Buildings = 11%**
**Agriculture = 10%**

## Manage impacts

**Natural environment**
**Built environment**
**Public health and safety**
**Socio-economic activities**

# Supporting Quebec strategy on adaptation to CC

www.ouranos.ca


**A government that strengthens the resilience of québec society through commitment and action.**

Québec

| ISSUE 1 | ISSUE 2 | ISSUE 3 | ISSUE 4 |
|---|---|---|---|
| The well-being of the population and communities | The continuity of economic activities | The safety and durability of buildings and infrastructures | The maintenance of essential ecological services |

STRATEGIC DIRECTION 1
Integrate climate change adaptation into the public administration

STRATEGIC DIRECTION 2
Develop knowledge and know-how

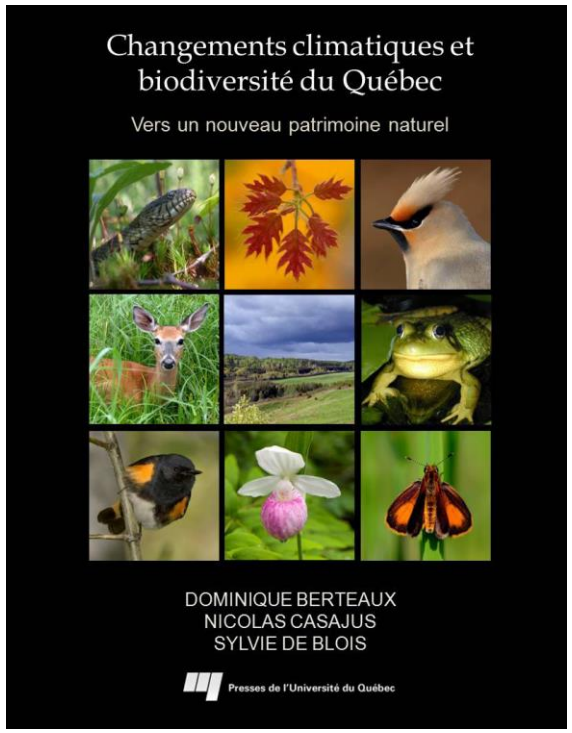
STRATEGIC DIRECTION 3
Build awareness and provide training

STRATEGIC DIRECTION 4
Modify land use and manage risks to reduce vulnerabilities

| STRATEGIC DIRECTION 5 | STRATEGIC DIRECTION 6 | STRATEGIC DIRECTION 7 | STRATEGIC DIRECTION 8 |
|---|---|---|---|
| **Maintain the health of individuals and communities** | **Preserve economic prosperity** | **Improve the safety and longevity of buildings and infrastructures** | **Conserve biodiversity and the benefits of ecosystems** |

# Resources with higher probability of usage

www.ouranos.ca



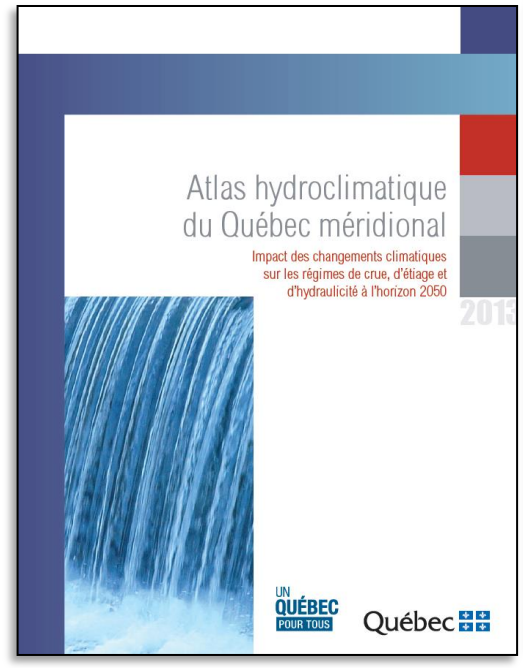

## Books


## Guides


## Factsheets


## Scientific reports

- **hydroclimatic Atlas**
  http://www.cehq.gouv.qc.ca/hydrometrie/atlas/atlas_hydroclimatique.pdf
- **Engineering Atlas**
  http://scenarios.ouranos.ca/fiches_infrastructures/
- **Northern biodiversity Atlas**
  http://www.mddelcc.gouv.qc.ca/biodiversite/atlas/
- **Agroclimatic Atlas**
  www.agrometeo.org
- **Forests indicators Atlas**
  http://www.ouranos.ca/media/publication/162_AtlasForet2011.pdf




# Our recommendations for Canada-wide adaptation

www.ouranos.ca

**Presented to the Federal/Provincial/Territorial Working Group on Adaptation and Climate Resilience**


## 1 It is urgent to act now

Climate risks ⬆
Investments and interventions ⬆ vulnerabilities

## 2 Mainstream adaptation into decision-making at every government level

Priority: **ESIA processes** and **infrastructure investments**

## 3 Collaborate efficiently at all levels

Levels of government ⟷ Sectors ⟷ R&D disciplines ⟷ Targeted groups: DM - Managers - Practitioners

## 4 Prioritize R&D to innovate in adaptation

Priority: **natural sciences** and **social sciences BUT involving end-users**

## 5 A national adaptation strategy is essential

Short-medium term actions contributing to a long term vision
Priority: **Strong climate services for national/regional/local needs**


Document complet: www.ouranos.ca