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XIII^e CONGRÈS INTERNATIONAL DE LA VIABILITÉ HIVERNALE

QUÉBEC, DU 8 AU 11 FÉVRIER 2010

LA VIABILITÉ HIVERNALE DURABLE AU SERVICE DES USAGERS

Analysis of regional climate model simulations of transport-related climate indices over Southern Quebec

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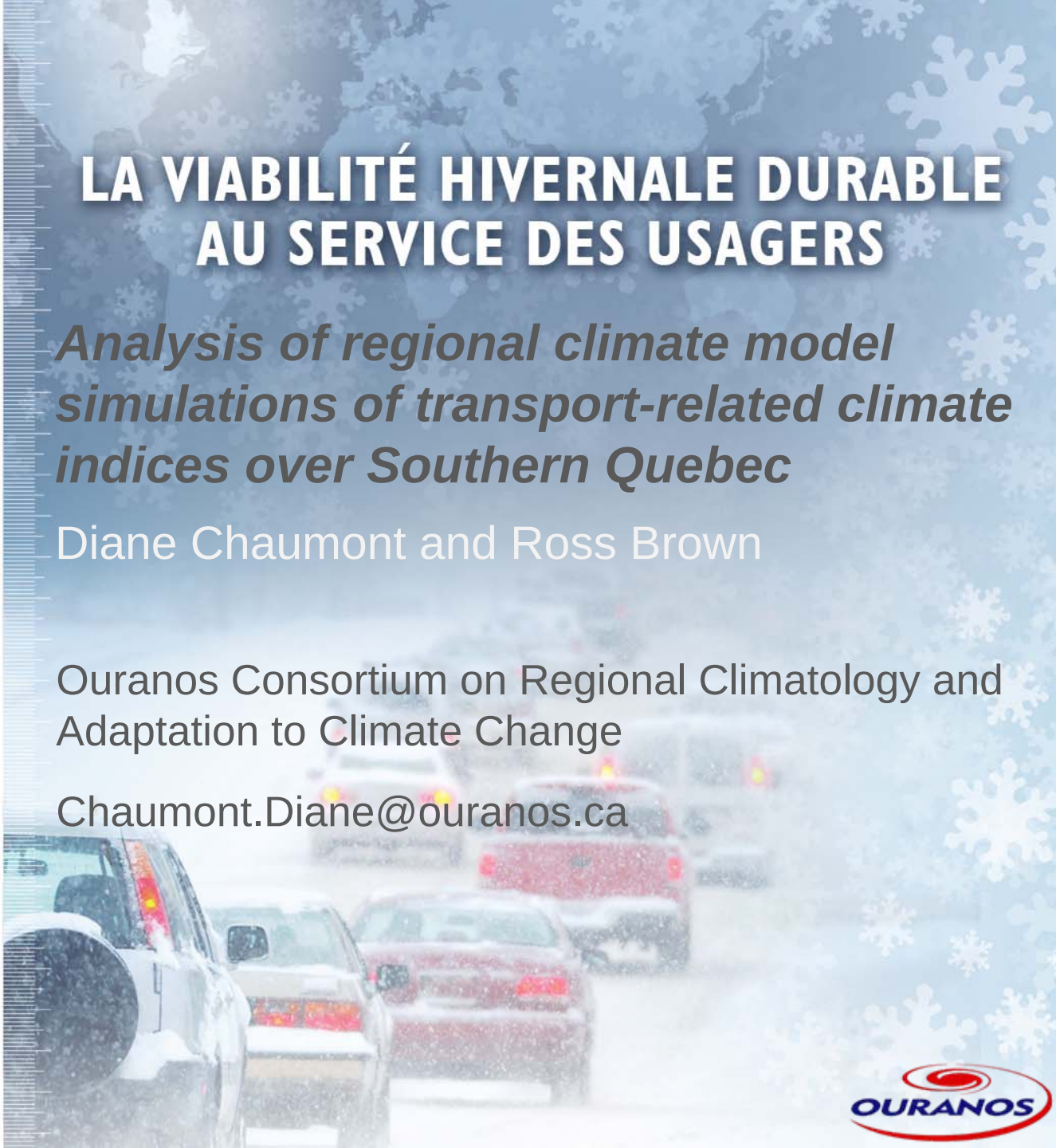

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Outline

- Context and Goals of the study
- Regional climate system and climate change projection
- Selection of climate transport related indicators
- Validation of the Canadian Regional Climate Model for the climate indicators
- Projected change and robustness
- Concluding remarks

Context

IPCC 4th assessment (2007):
Climate model simulations suggest that:

- winter warming is *very likely*
- increase in precipitation is *likely*
- reduction in snow cover duration and depth is *very likely*

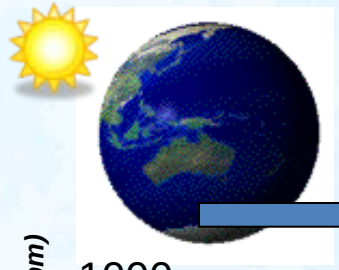
Related impacts:

- Some benefits such as reductions in snow and ice removal costs and an extension of the construction season.
- Potential for more freeze-thaw conditions in some parts of the study region, increases in snowfall extremes and increased risk of mixed precipitation events

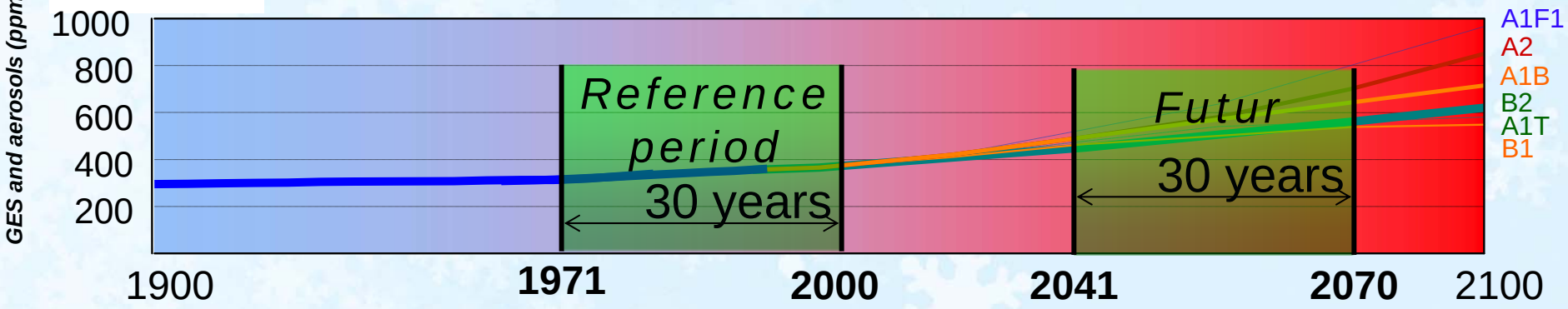
Main goals of the study

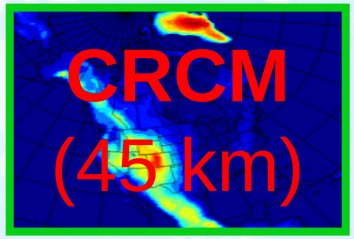
1. Evaluate the capacity of Canadian Regional Climate Model (CRCM) to simulate winter climate indicators relevant to transportation infrastructure and road conditions in the Southern Quebec region
2. Present information on simulated changes in these indicators and their levels of consistency based on an ensemble of regional climate simulations

Climate simulation and projection system



Observations





Regional Climate (reference)

CC Analysis

Regional Climate (futur)

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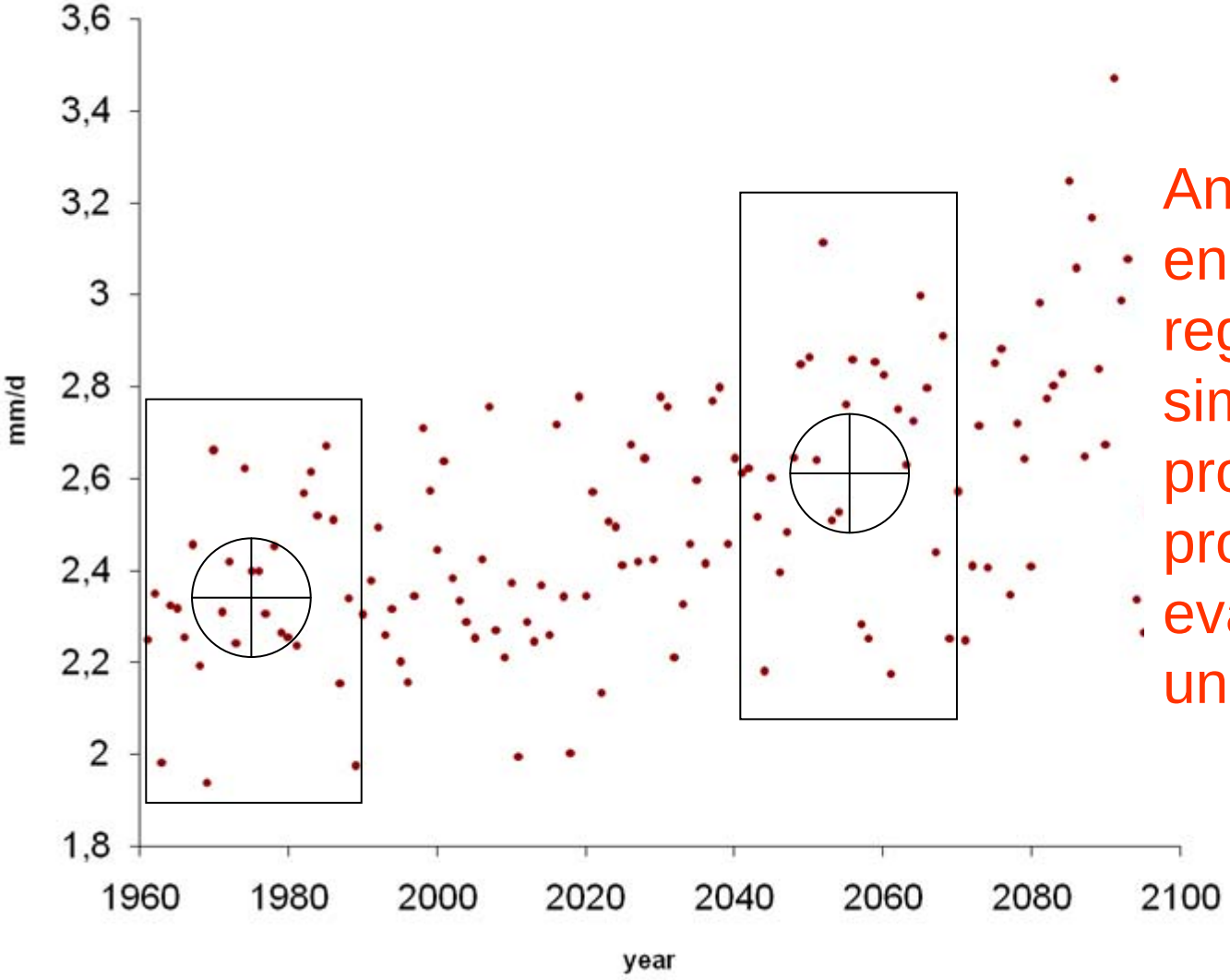
Climate change analysis

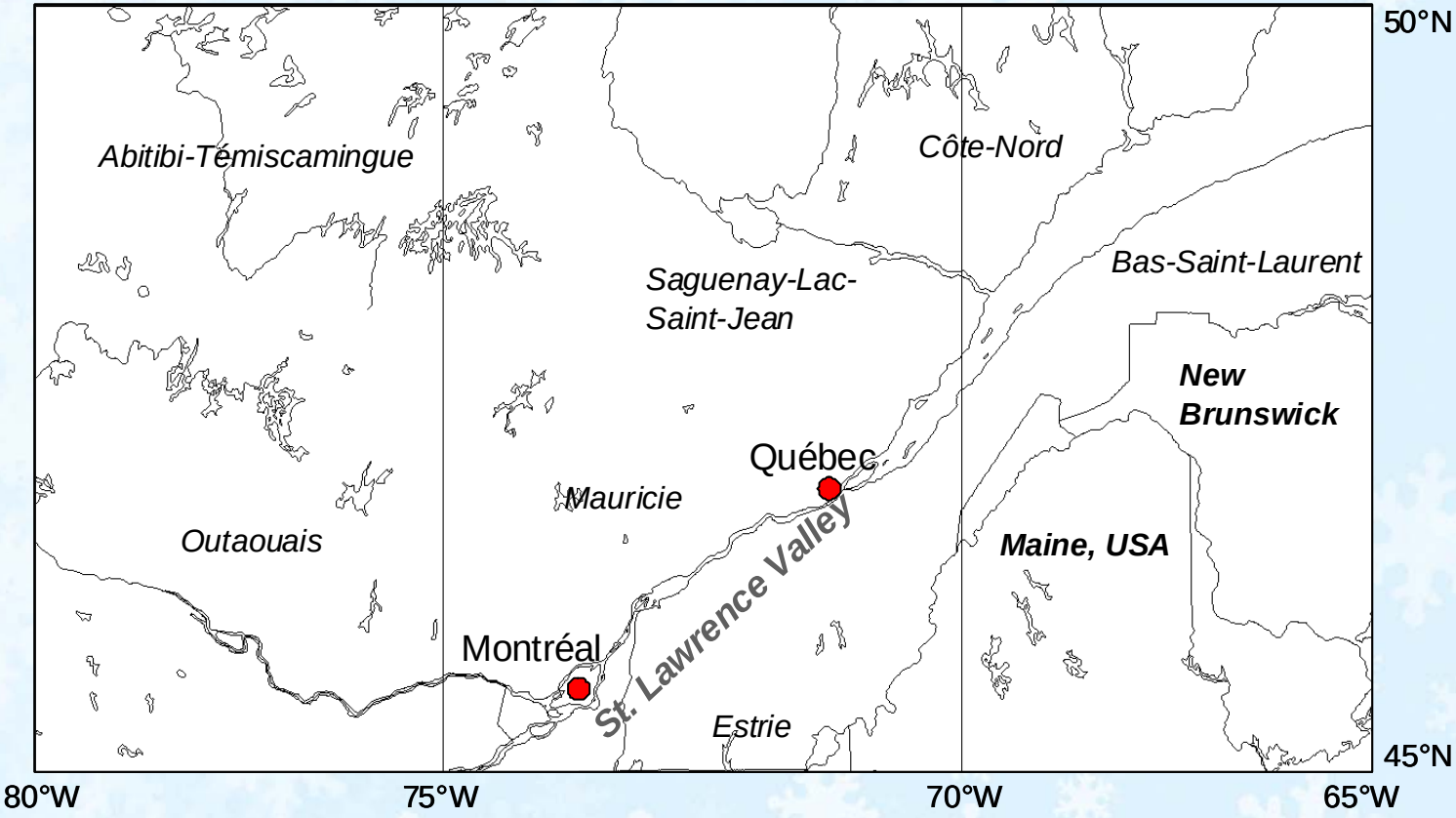
Precipitation over a given area



Analysis of an ensemble of 5 regional climate simulations and projections provide an evaluation of the uncertainty

Area of interest

Most of Quebec's population and transport infrastructure are concentrated in the southern region of the province containing the two major urban areas of Montreal (population 3.6 million) and Québec City (population 0.7 million)



Transport related climate indices

Temperature indices	Precipitation indices
Winter freeze onset date	# Winter rainfall events
Spring thaw onset date	Winter rainfall event duration
Winter duration	Winter rainfall event amount
Cumulative sum of freezing degree-days	# Snowfall events
# Daily freeze-thaw cycles	Snowfall event duration
# Winter thaws	Snowfall event amount
Winter thaw event duration	
Thaw event thawing degree-days	

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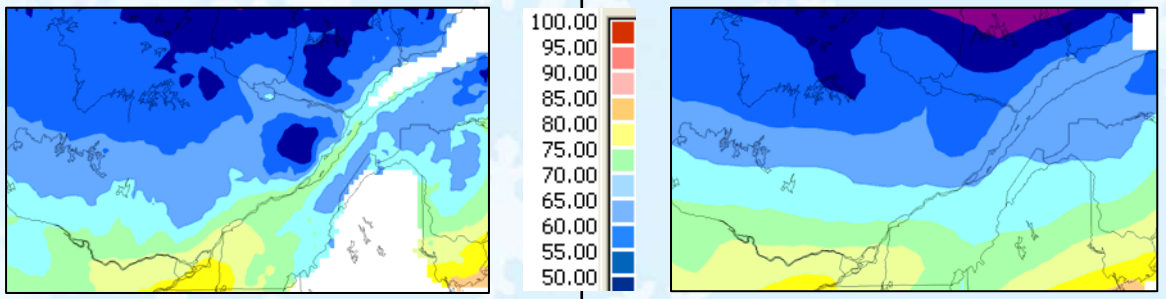
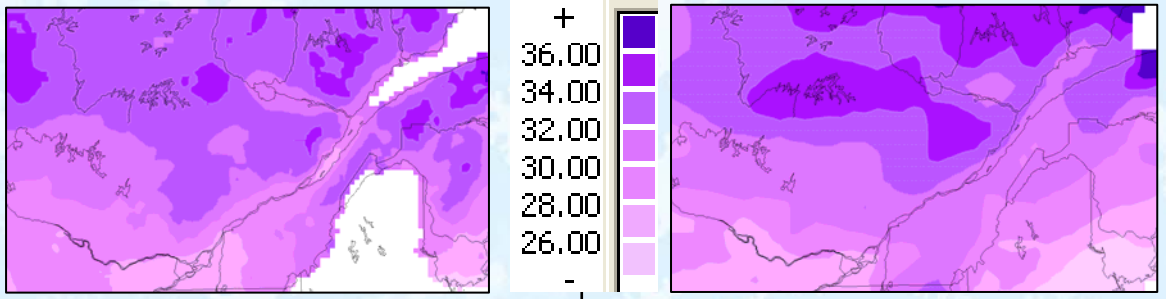
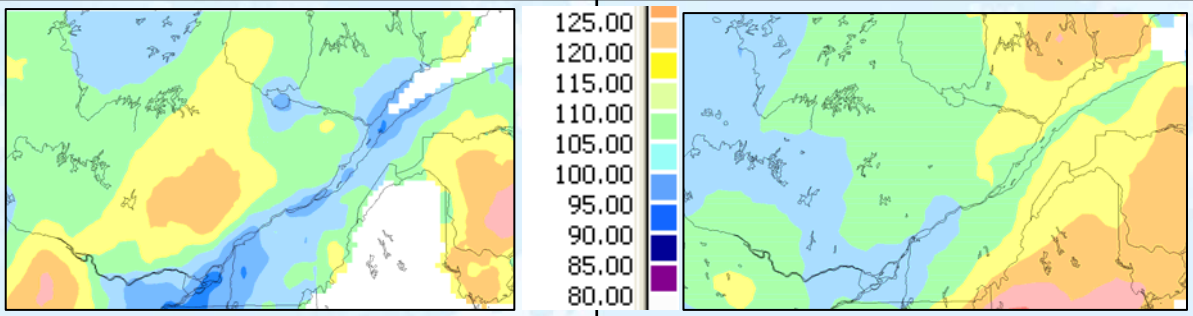
CRCM evaluation

Winter climate index	**Obs. Current Climate 1971-2000 from NLWIS @ 10 km resolution**	CRCM Current Climate 1971-2000 (avg. of 5 simulations) @ 45 km*
Mean date of freeze onset (Julian day wrt Aug 01)		
Mean annual number of snowfall events		

* Mean bias removed

NLWIS: *National Land and Water Information Service*

CRCM evaluation - continued

Winter climate index	**Obs. Current Climate 1971-2000 from NLWIS @ 10 km resolution**	CRCM Current Climate 1971-2000 (avg. of 5 simulations) @ 45 km*
Mean annual number of daily freeze-thaw cycles		

* Mean bias removed

Results of the evaluation :

- CRCM provides realistic spatial patterns over the study domain for most indicators.
- Some exceptions : number of daily freeze-thaw cycles and winter thaw events.

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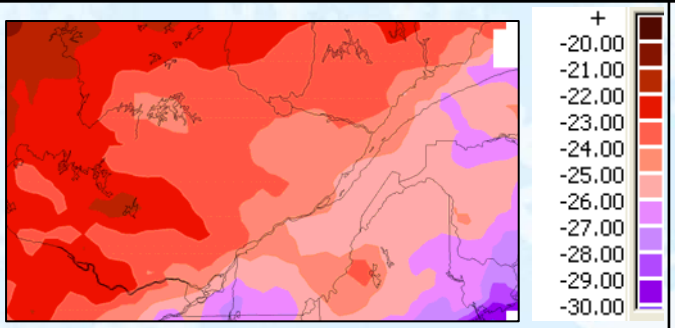
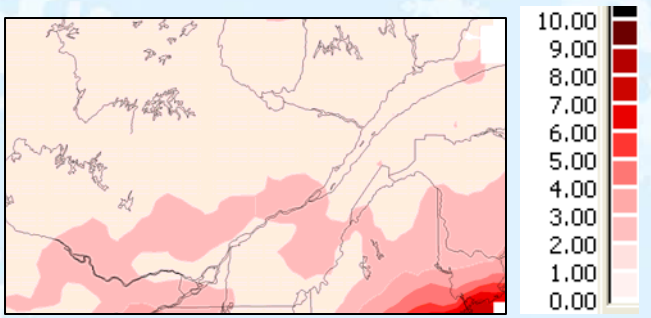
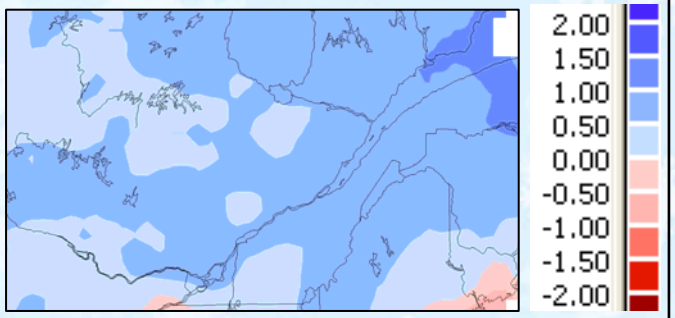
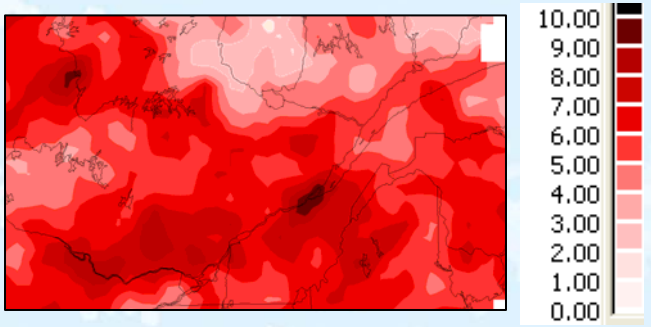
CRCM projected changes

Winter climate index	Mean simulated change 2041-2070 minus 1971-2000 from 5 CRCM simulations	Standard deviation of 2041-2070 averages from 5 CRCM climate simulations (% of mean)
Mean duration of freeze period (days)		
Mean annual number of winter rainfall events		

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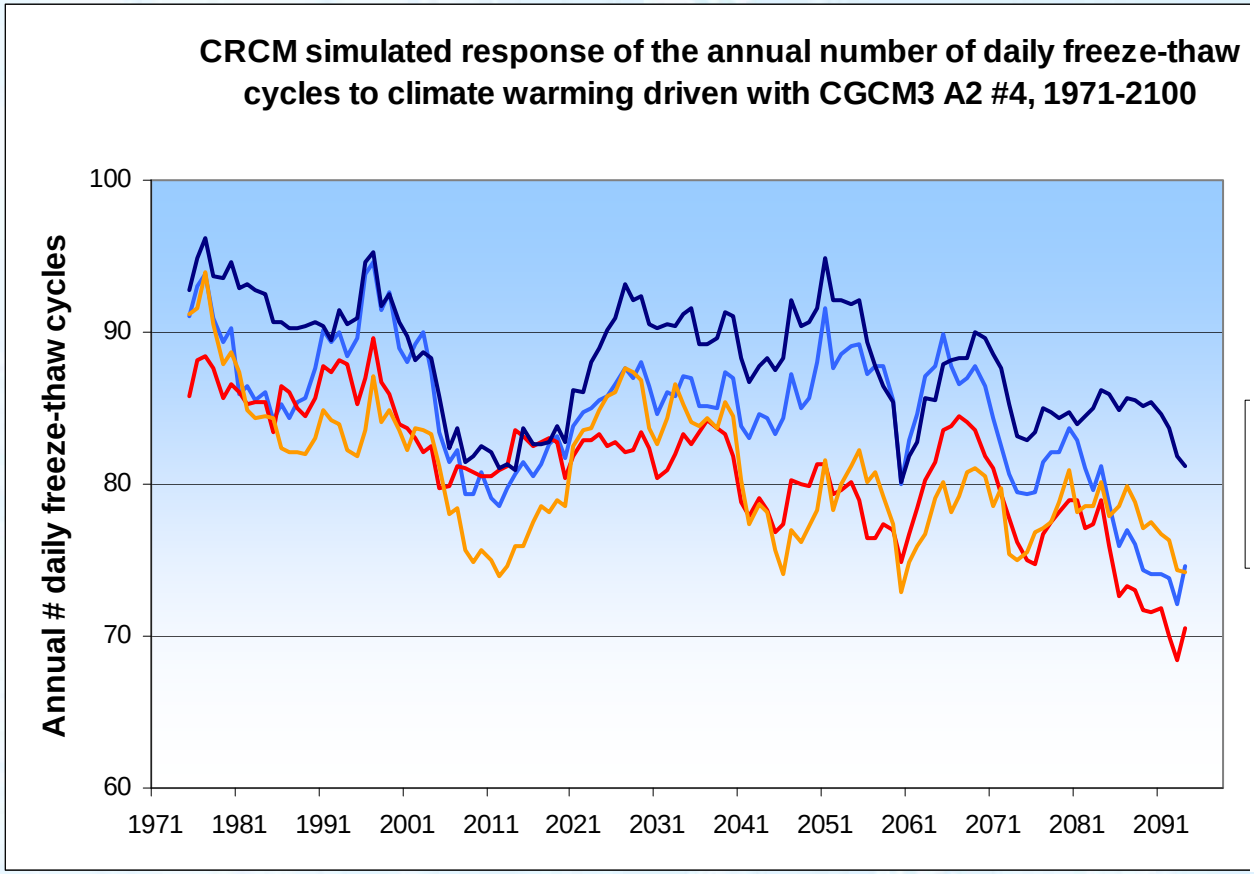
CRCM simulated variability in the number of daily freeze-thaw cycles



- Large decadal- and multi-decadal variability superimposed on a long-term downward trend.
- The future climate response of this index could include periods with increasing freeze-thaw cycles.
- Analysis of long-term trends is necessary to estimate the climate change signal

* Analysis at four grid points from different regions of Québec.

Values have been filtered with a centred 9-year running mean.

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Concluding remarks

Generally warmer and wetter future winter climate by 2050 based on climate model projections.

- Shorter winter freeze season by 24 days
- Increase in number of winter rainfall events ~10%
- Increase of event precipitation amounts by ~10% and ~20% for snowfall and rainfall
- Decrease in number of freeze-thaw cycles
- For some indices, large decadal- and multi-decadal variability superimposed on a long-term downward trend
- Able to provide estimates of uncertainties linked to natural climate variability by the use of an ensemble of climate simulations