Environment Canada Environnement Canada

Canada

CCCSN Information and Tools for Conservation Authorities

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February 2011

Canadian Climate Change Scenarios Network

- CCCSN provides access to **ALL** IPCC Models (~24 including Canadian Model) and the ENSEMBLE
- Mechanism is the Canadian Climate Change Scenarios Network (CCCSN.CA) – an EC/University Partner site
- GCMs, RCMs, statistical downscaling
- Through a Grant and Contribution Agreement with the University of Regina – PRECIS regional model at ~45km for all of Canada, more runs underway

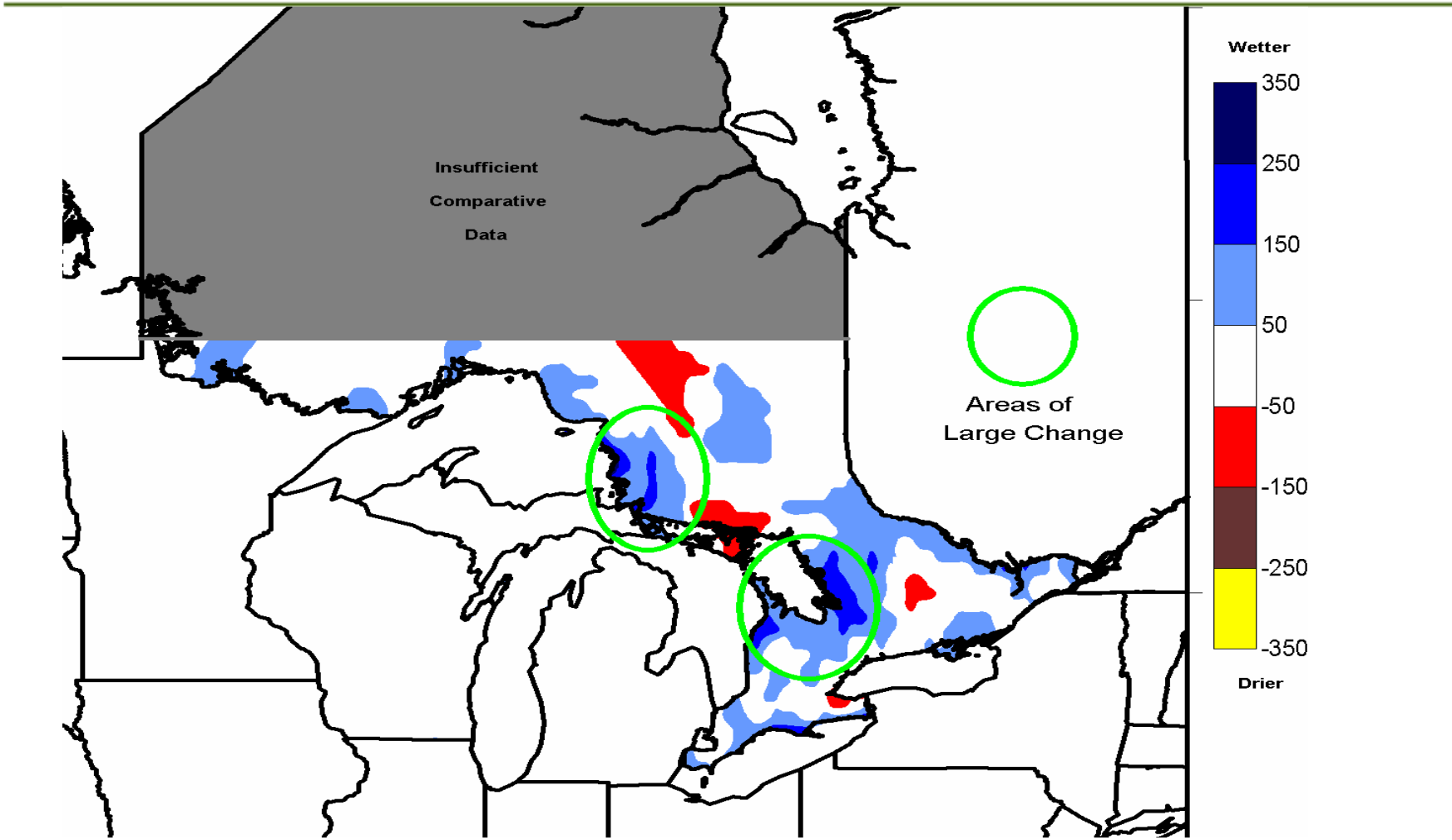
Adaptation and Impacts Research (AIRS) research themes and applications:

- Climate extremes / energy models
- Water resources and coastal zones
- Transportation
- Human health and safety
- Infrastructure (building codes, standards)
- Primary Industry (mining, forestry)
- Agriculture
- Biodiversity and Protected Areas
- Tourism

…with many different stakeholders (domestic and international)

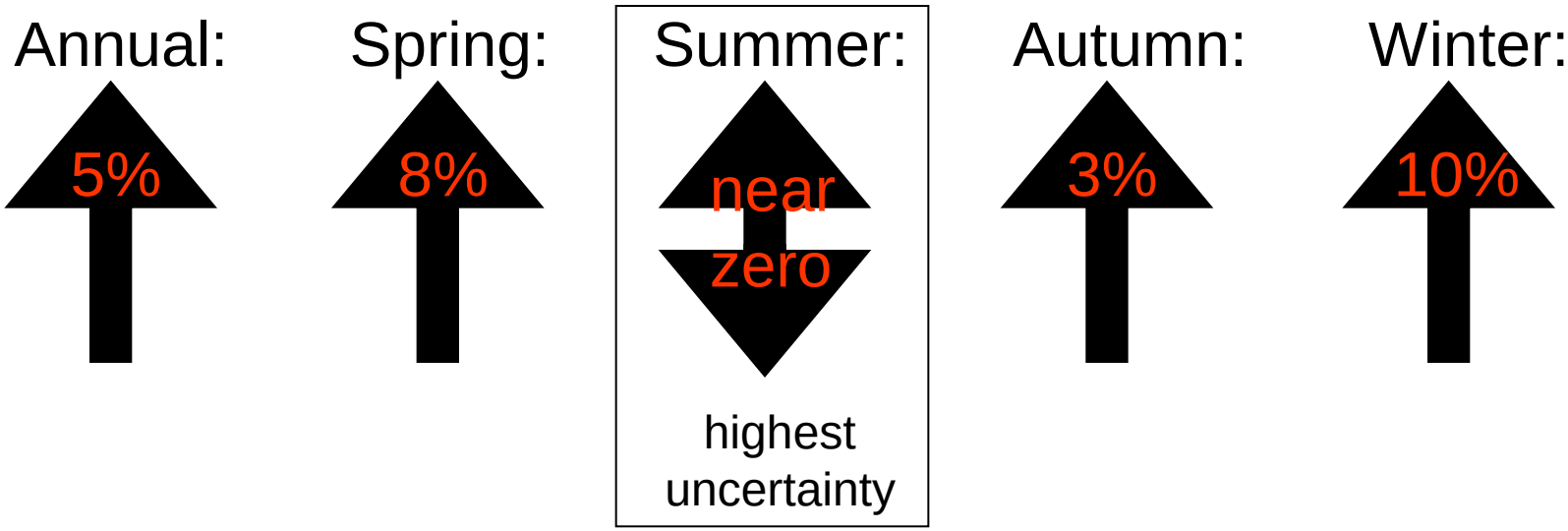
The climate is already changing

Annual Precipitation Difference between two normals periods (1951-1980) and (1971-2000)



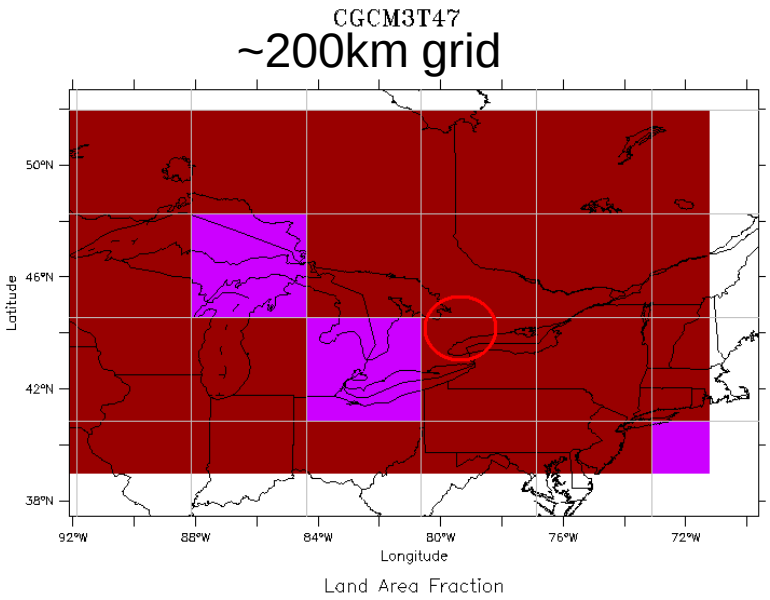
Precipitation Projections

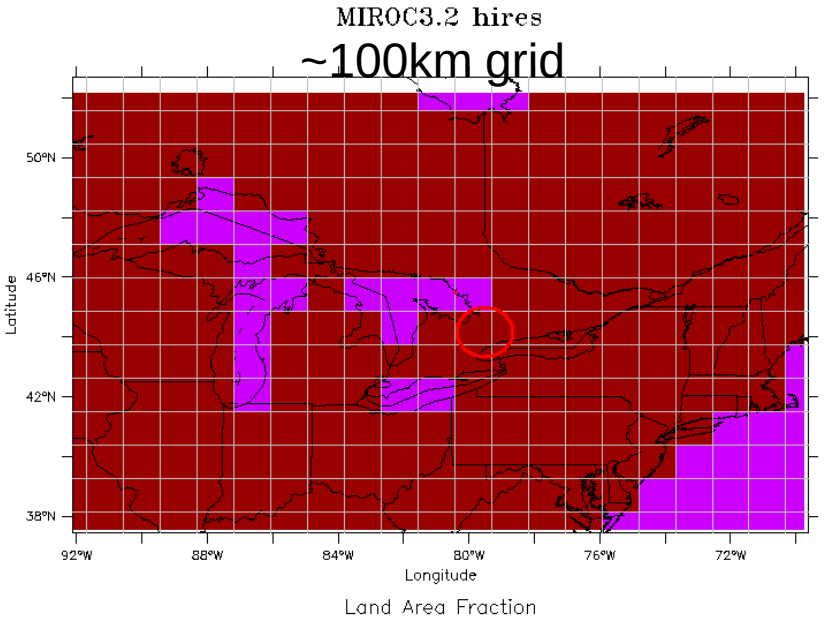
- GCM ensemble precipitation change in 2050s (A1B) over several grid cells:

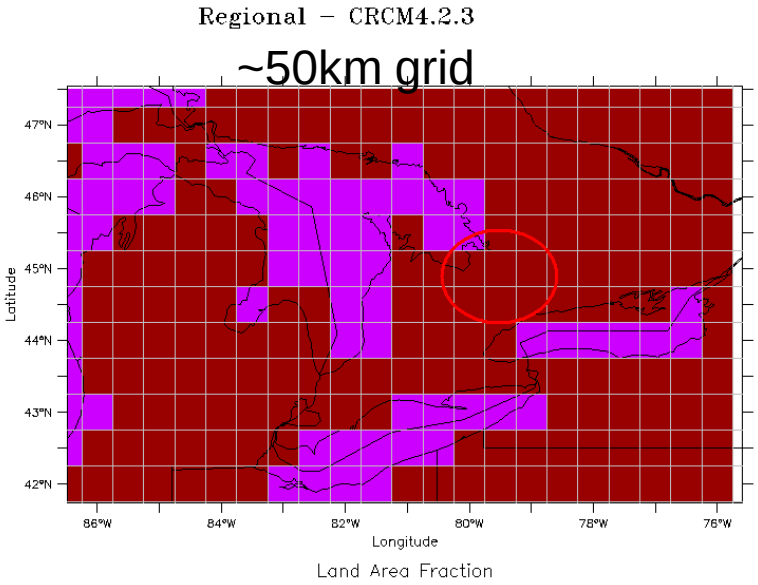


(Based upon 24 GCMs, 1971-2000 baseline change for 2050s)

Model Resolution → GCM to RCM



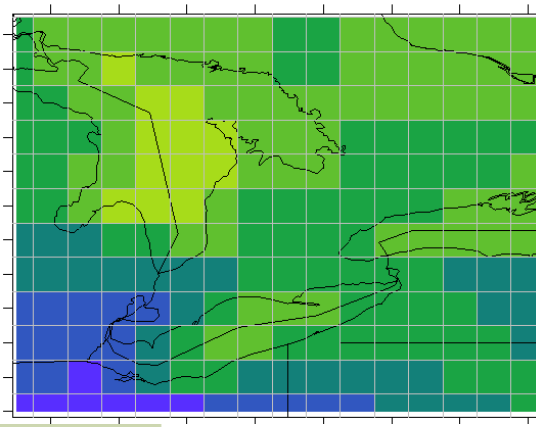




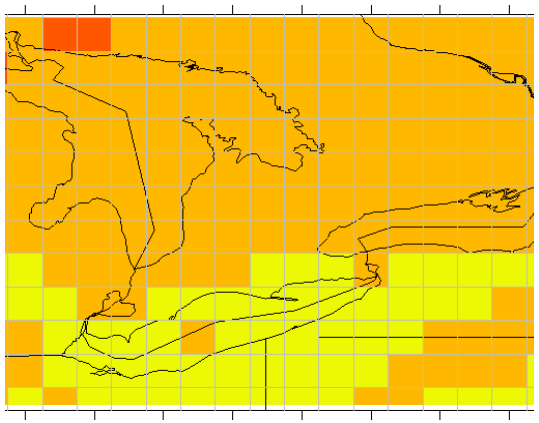
- Regional Climate Models are increasingly computationally expensive
- High resolution RCMs can take months of run-time
- RCMs require boundary conditions from GCMs (so not completely independent)

Canada

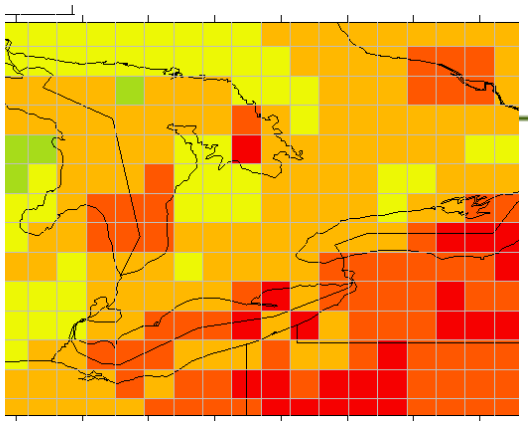
RCM Annual Precip Change in 2050s



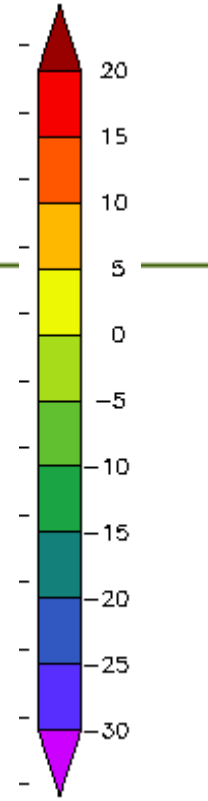
ARPEGE (A2)



CRCM4.2.3 (A2)



PRECIS 1.8.2 (A1B)



10%

5%

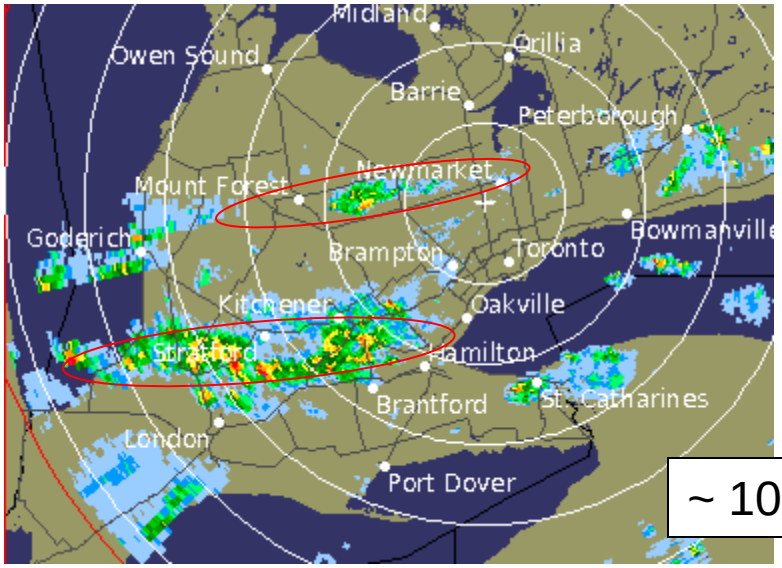
5%

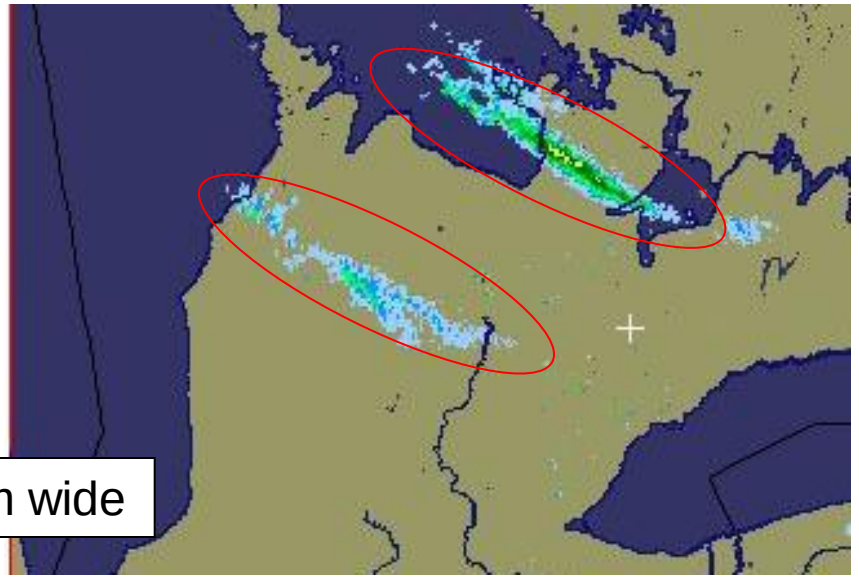
- Annually, similar to GCMs
- Differences between models, as with GCMs (higher resolution ≠ consensus)
- Larger differences between models at the seasonal scale, especially SUMMER

See also, NARCCAP (North American Regional Climate Change Assessment Program). www.narccap.ucar.edu for more regional model output (6 RCMs)

The precipitation issue…

- Often occur at scales much smaller than current climate models operate, so grid-cell (especially extremes) are not very useful (they tend to underestimate)
- Local Convective events (T-storms) and local topographical/coastal events (Lake effect) may not be resolvable
- There is both a spatial and temporal mismatch





~ 10km wide

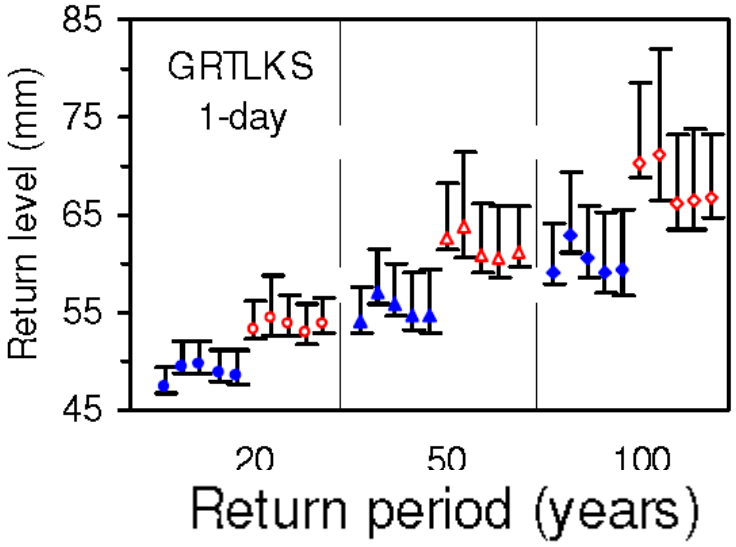
Models do provide

- GCMs-daily precip; RCMs down to 1, 3 or 6 hourly
- Some model calculated extremes:

  Days with rain > 10mm — Simple daily intensity index

  Consecutive dry days — 3 or 5 Day precip max amount

  Days of total precip > 95th percentile value
- New research using CRCM for extreme precip at subdaily, 1, 2, 3, 5, 7 and 10 day totals ⟶ increase



1961-1990 model runs

2050s model runs

Mladjic et al (2011) Canadian RCM projected changes to extreme precipitation characteristics over Canada

Option: Statistical Downscaling e.g. Rainfall-related Weather Map Typing

Cheng et al., 2009

- Found 10 Rainfall-related Weather Types for **DAILY** Heavy Rainfall

- Events for 4 Selected River Basins in Ontario Results indicate an **INCREASE** in **all** future return period values investigated: **climate model ensemble results in 21st century relative to the historical 1961-2000 period**
- **Meteorological processes approaches – may be best**

	FUTURE PERIOD– emission dependent		
	2001-2050	2026-2075	2051-2100
Thames River Basin	~+23%	+27-29%	+21-32%
Grand River Basin	+41-59%	+40-56%	+47-69%
Humber River Basin	+ 38-42%	+43-60%	+46-70%
Rideau River Basin	+33-37%	~+37%	+42-50%

IPCC/Model likelihoods for S. Ont:

- Increased frequency of heavy precipitation events (T-storms, tornado, synoptic storms)
- Northerly shift in storm tracks
- Relative increase in extremes is likely greater than that of means
- More frequent summer dry spells/heatwaves
- Reduced snowpack, more winter rain
- Earlier spring freshet
- Higher winter flow
- Hurricanes: Increased intensity? Lower frequency?

Impacts:

River flow change? Dilution factors? Ecosystem habitat? Lake levels? Flood control? Combined Sewers?

Why Monitoring is Important…

- We can see the climate change over time – understand variability
- Model validation
- Some events we cannot determine from climate model projections and likely never will – but they are very important
  - too fine a spatial scale AND temporal scale
  - examples: tornadoes, thunderstorms, hailstorms

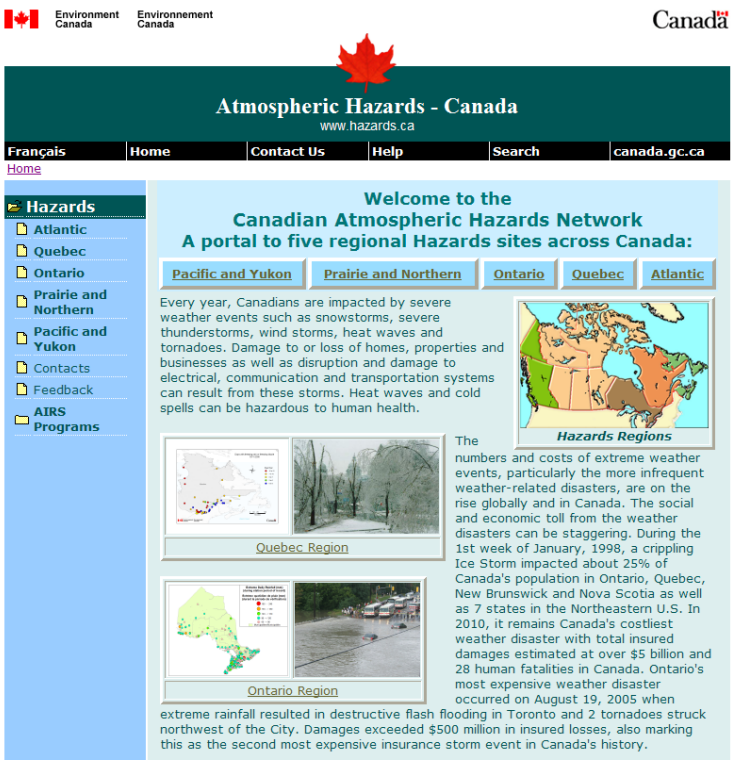
    →Historical trends may be all we have to go on
- Statistical downscaling can help with some extremes, but requires reliable long-term observations to apply and operational expertise

CAREFUL MONITORING OF CLIMATE IS CRITICAL

Filling the gap… AIRS product:

Atmospheric Hazards

(www.hazards.ca)



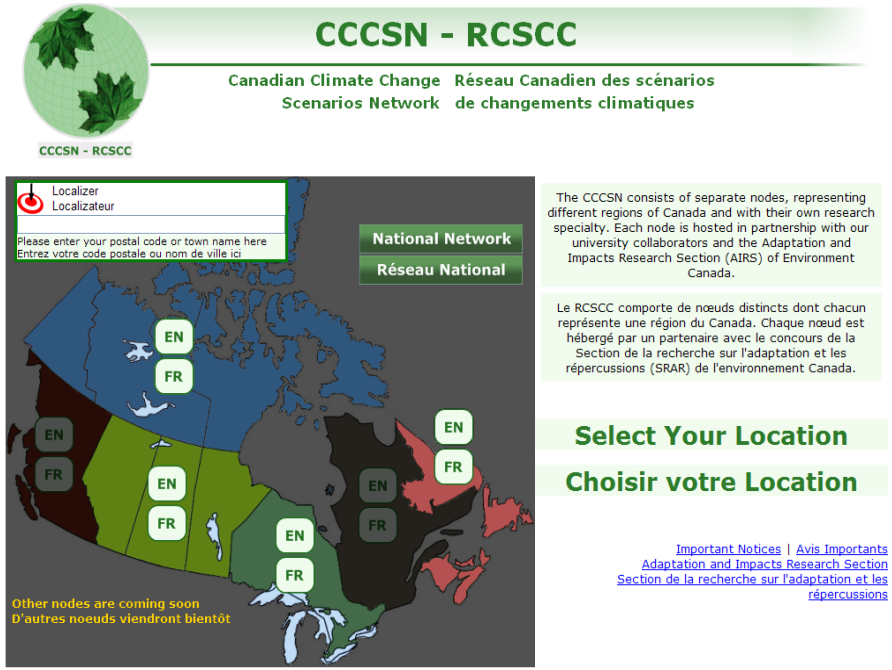
- Historical weather-related event frequencies across Canada
- Heat, cold, flood, tornado, hurricane, human health, wind, etc.
- Specific event listings

COMING SOON:

hazard projections from GCMs

Filling the gap… AIRS product:

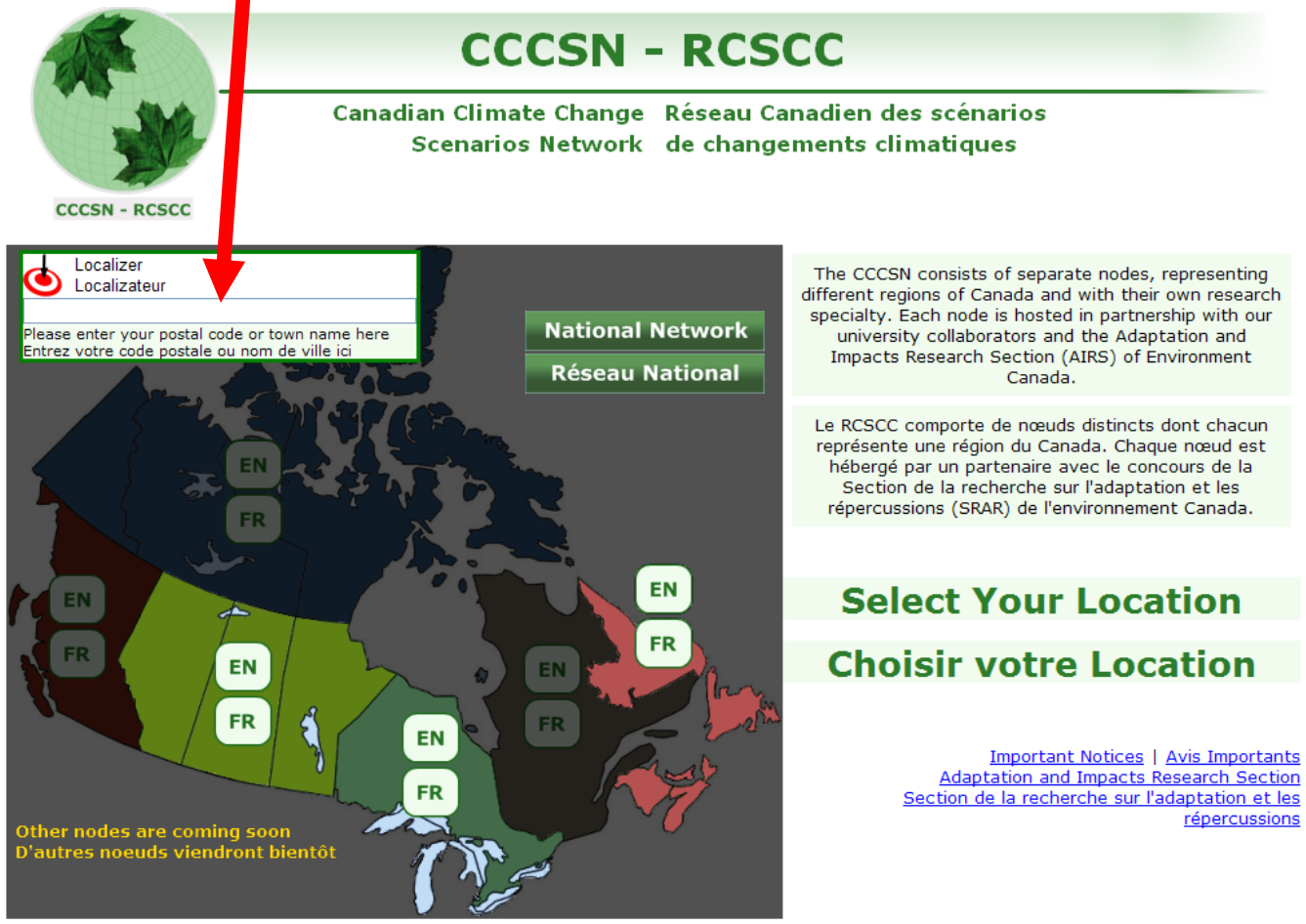
The Canadian Climate Change Scenarios Network (CCCSN.CA) (www.cccsn.ca)



- University Partnership
- GCM and RCM data, tools
- Added-value 'Bioclimate profiles' on degree days, frost/freeze, water budget, temperature exceedances, etc.
- ENSEMBLE results – an average of ALL GCM models for temperature and precipitation so no decision on which models to use
- NEW design of site to better reflect regional research

15 *Making it local - the 'Localizer' <ENSEMBLE>*

For a customized summary report on climate change projections for your location, simply enter your town name here



PARTIAL SAMPLE OUTPUT of all-model ENSEMBLE

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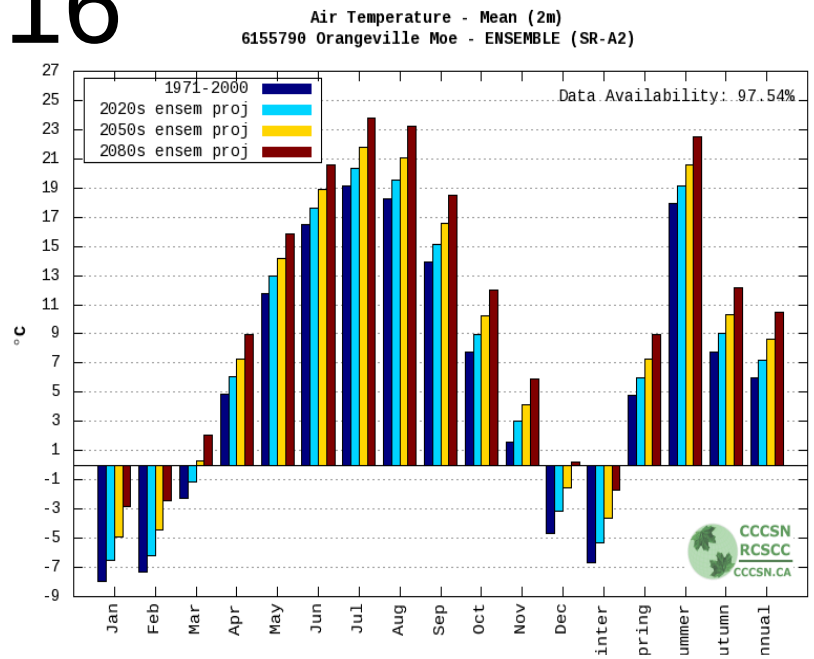

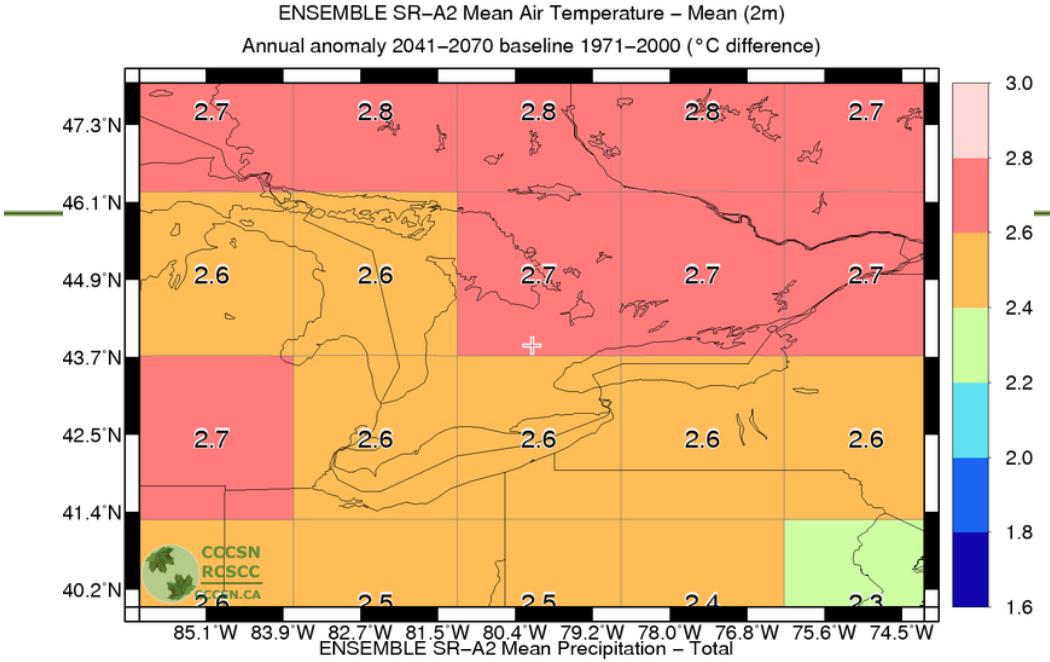

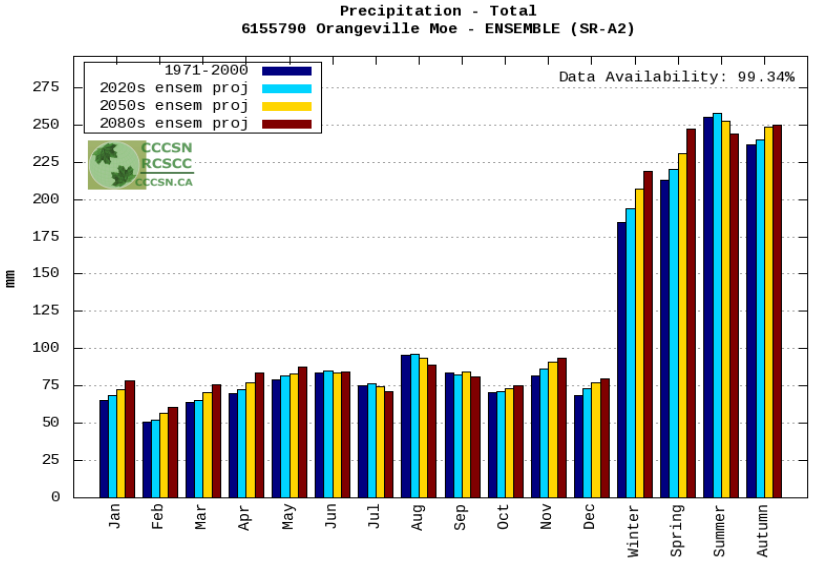

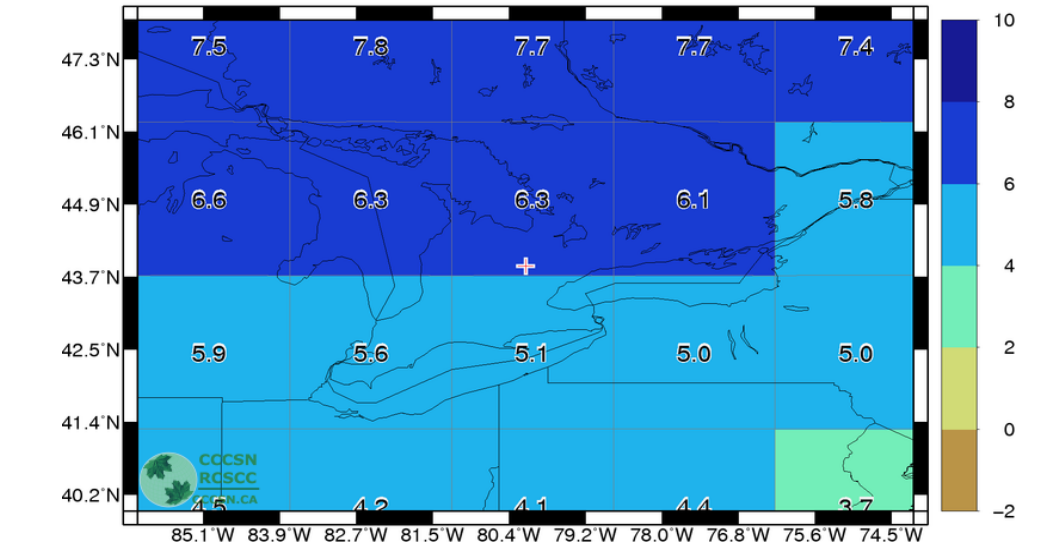

THE FUTURE?

- Certainly more models – RCMs
- Higher resolution RCMs (~10km)…. but even with a model at 1km resolution, extreme, small-scale convective events can be missed → so we can play the resolution game forever; *the models will never be perfect*
- Statistical downscaling can help at smaller scales – uses model output

Uncertainty:

- The output of one model or even multiple runs of a single model only tells us the internal model uncertainty – not the real **climate** uncertainty
- The best we can do is to CONSIDER MANY MODELS, assuming that each produces equally probable/realistic outcomes → ENSEMBLES
- Note that some end–users are completely comfortable with uncertainty (engineering), since they deal with it all the time ('safety factors')→ RISK MANAGEMENT

Uncertainty should not prevent us from making sound, 'no regrets' decisions now

Adaptation and Impacts Research Section (AIRS):

CCCSN.CA/airs

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Thank you