The Canadian RCM: Presentation of The Model and Example Applications

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and the Ouranos Climate Simulation Team

Outline

- A few words about Ouranos
- Presentation of the CRCM
- Some end-users examples
- Last minute slides

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Narccap users’ meeting

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The Ouranos Consortium: Unique in Canada

550 Sherbrooke West
Montréal
www.ouranos.ca
(near UQÀM, McGill, INRS, HQ …)
18th and 19th floors, 1800 m²

- Coordination of interdisciplinary research
- 90 scientists, students and professionals working together at the same location
- Access to an extensive network of experts, users and true stakeholders
The mission of Ouranos is to acquire and develop knowledge on climate change and its impacts, as well as on socio-economic and environmental vulnerabilities, so as to inform decision makers on evolution of the climate and to provide advice on the identification, evaluation, promotion, and implementation of local and regional adaptation strategies.
Impacts Linked to Climate Change in Quebec

- Permafrost
- Coastal erosion
- Energy and Forestry
- Urban Infrastructures
- Water resources
- Other economic sectors
- Health, Public Safety and Extreme events
- Ecosystems and Biodiversity
Ouranos Climate Simulation Team and Equipment

- Team of 8 climate simulation specialists
- Two Cray-SX vector computers
- Two SGI front ends (Sun – coming soon)
- One data server (tape + robot)
- One main tool to produce climate data: the Canadian Regional Model (CRCM)
Usual set-up:
- 45km resolution
- 29 levels
- 15min timesteps

Special features:
- precipitation available at every timestep
- Large scale nudging
- CLASS land surface scheme with explicit layer for snow cover
Other grids...

Narccap vs AMNO

ENSEMBLE

ICTS  DX=50km

109x109 @50km
209x209 @25km
CRCM operational set-up at Ouranos

CRCM
CGCM2
CGCM3
NCEP rean1
NCEP rean2
ERA40C

Different grids

Different IC

Different CRCM Versions

Different scenarios

Ensemble of Climate simulations for validation and projection
A few examples of CRCM data use

• Water budget and snow analysis
• Precipitation extremes
The Great Lakes

Superior

Huron

Michigan

Erie

Courtesy of Guay and Frigon
Annual land runoff [mm/y]

- acw: ERA40d driven
- ade: NCEP driven

1961-1999
- CRCM_acw 306 106%
- CRCM_ade 290 100%
- GLERL OBS 289

1961-1999
- CRCM_acw 204 59%
- CRCM_ade 198 57%
- GLERL OBS 344

Courtesy of Caya, Frigon and Music
CRCM validation summary

1961-1999 land basin runoff validation

Land runoff over land (mm/year)

- GLERL OBS
- CRCM acw/ERA40d
- CRCM ade/NCEP

SUP: 204, 344
MIC: 198, 283
HGB: 213, 306, 286, 281
ERI: 298, 306, 289, 290
UGL: 245, 241

Courtesy of Caya, Frigon and Music
Hydrology over bassin

45km CRCM grid-size mesh

Courtesy of Slivitzky and Frigon
Annual runoff bias 1961-1999

Runoff $\sim 1.5$ mm/d

Courtesy of Slivitzky and Frigon
Churchill Falls Reservoir
1961-1999
Maximum snow water equivalent (mm)

Courtesy of Slivitsky and Frigon
Lac Saint-Jean 1961-1999
Maximum snow water equivalent (mm)

Driven by:
Era40
NCEP rean 2

Courtesy of Slivitsky and Frigon
Cumulative distribution for 24 h extreme – RCM vs Mtl airport

Intensité (mm/jour)

Probabilité cumulative

Dorval

68-33

68-32

Courtesy of Mailhot, Duchesne and Simard
Cumulative distribution for 12 h extreme – RCM vs Mtl airport

Hauteur d'eau (mm)

Probabilité cumulative

Tuile 68-33 12 h
Dorval 12 h
Tuile 68-32 12h

Courtesy of Mailhot, Duchesne and Simard
Cumulative distribution for 6h extreme – RCM vs Mtl airport

- Tuile 68-33 6h
- Tuile 68-32 6h
- Dorval 6h

Hauteur d'eau (mm)

Probabilité cumulative

Hauteur d'eau (mm)
Cumulative distribution for 2 h extreme – RCM vs Mtl airport

Courtesy of Mailhot, Duchesne and Simard

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Cumulative distribution for 1 h extreme – RCM vs Mtl airport

Hauteur d'eau (mm) vs Probabilité cumulative

Tuile 68-33 1h
Tuile 68-32 1h
Dorval 1h

Courtesy of Mailhot, Duchesne and Simard

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Last minute slides …
Validation climat 1961 - 1990

CRCM4 (45km)  
OBS CRU2 (0,5x0,5°)

Été (JJA) température 1961-1990 (°C)

Différence MRCC4 moins OBS CRU2
Validation climat 1961 - 1990

CRCM4 (45km)  OBS CRU2 (0,5x0,5°)

Précipitation d’été spatialement plus bruitée que les observations
Été (JJA) précipitation 1961-1990 (mm/d)

Différence MRCC4 moins OBS CRU2
A Poor’s Man Ensemble for North-America  
1971 - 1990 vs 2041 - 2060

<table>
<thead>
<tr>
<th>Name</th>
<th>Definition</th>
<th>CRCM version</th>
<th>Domain</th>
<th>Driving data</th>
<th>Projected scenario</th>
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</tbody>
</table>

From Plummer, Caya, Frigon, Côté, Giguère, Paquin, Biner, Harvey, de Elía  
J. Climate 2006
Plummer et al. J. Climate 2006

*Climate Change over North America as simulated by the CRCM*

Uncertainty is everywhere
Drought index

- Operational drought index (function of Tmax and precipitation) computed with different time series.

**CRCM4 grid**

- 250 km radius:
  - CRCM: 112 tiles
  - Observations: 13 stations
  - GCMs: closest tile

**CGCM3 grid**

Courtesy of Logan, Chaumont and Caya
Drought index

- Operational drought index (function of Tmax and precipitation) computed with different time series

**CRCM4 grid**
- 50 km radius
- MRCC: 5 tiles
- Observations: 1 station
- GCMs: closest tile

**CGCM3 grid**

Courtesy of Logan, Chaumont and Caya

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Drought index

Operational drought index (function of Tmax and precipitation) computed with different time series.

- **Radius of 250 km**: 13 stations, 112 tiles MRCC, 1 tile MCG.
- **Radius of 50 km**: 1 station, 5 tiles MRCC, 1 tile MCG.

Observations: 1 station, GCM: closest tile MRCC, 112 tiles MRCC, 1 tile MCG.

Courtesy of Logan, Chaumont and Caya.
Drought index change for the Boreal forest
MRCC4 - MCCG3 A2
2040-2069 à 1961-1990

Drought index units
Soil temperature

Observation sites of MRNF

Annual cycle of simulated soil temperature (1961-1990)

FORHYM2 without organic layer

FORHYM2

MRCC-Class
Summary

• The climate simulation team at Ouranos has produced a noticeable amount of regional climate simulation (validation and projection)
• Narccap to increase our pool of regional climate data (other RCMs, driving GCM, …)
• Users at Ouranos are using more and more direct RCM outputs in their I&A studies
Thank you!