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Environment Canada's Climate science supporting adaptation in Canada

Regional Climate Services Workshop 2011
Victoria, B.C.
Charles A. Lin
Atmospheric Science & Technology Directorate
November 22, 2011

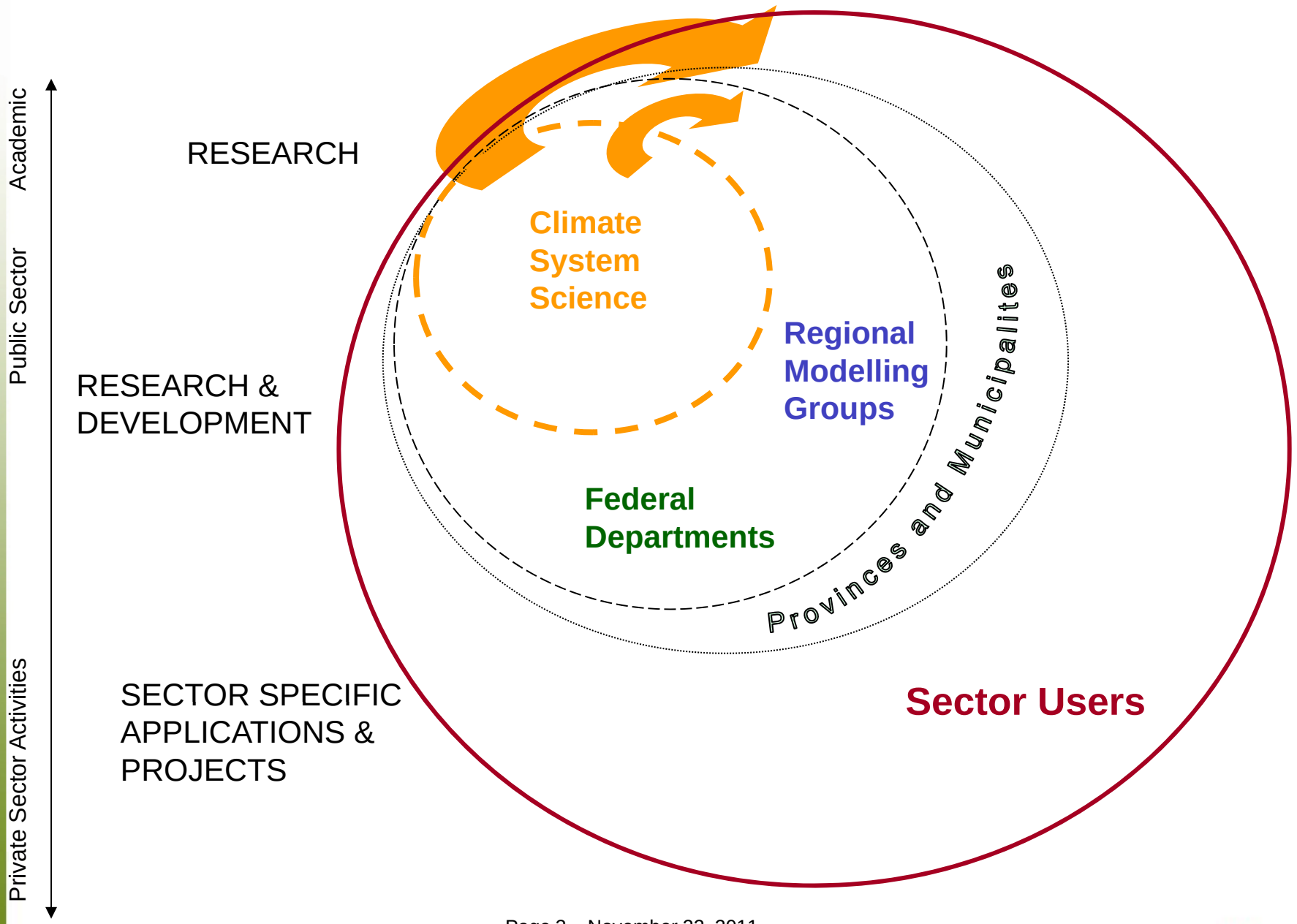
The adaptation and climate services challenges for Environment Canada

- **The premise:** Climate services inform and assist users in adapting to both present day climate variability and medium to long term changes in climate.

- **The challenge:** Adaptation is inherently local and regional while EC has a national mandate, thus there needs to be a balance in working with stakeholders

- **The relationships:** Climate services are part of the "innovation chain" linking the science that comprises the basis for development of the services, the service that produces and provides the services, and the users of the services, who also provide feedback on what is currently available and what will be needed in future.

- **The role:** EC provides foundational science and data on past, present and future climates needed for adaptation.



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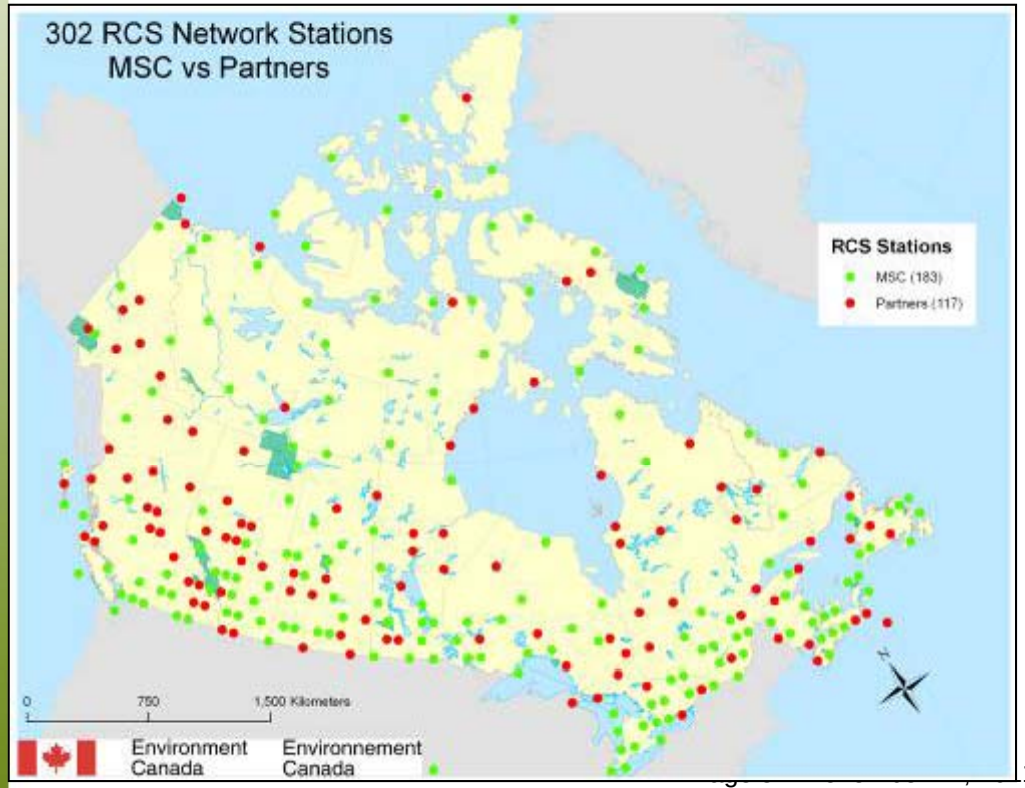
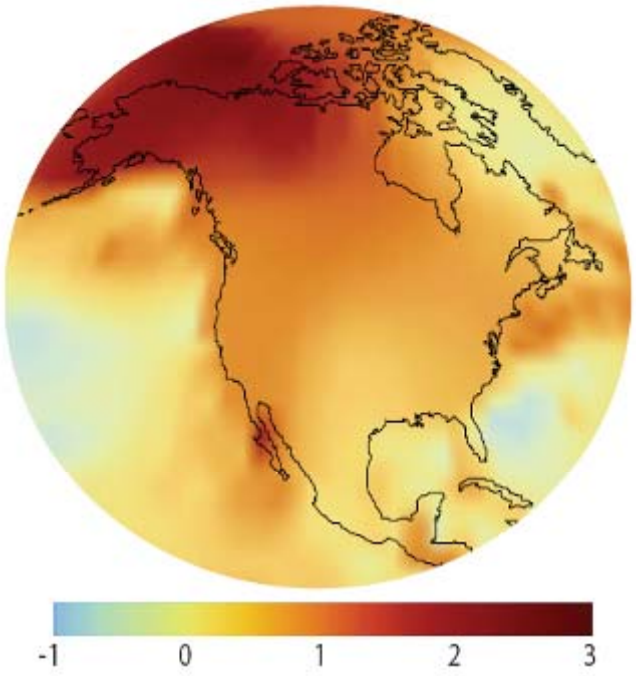
EC's role: Providing knowledge and information

- What is changing? Why the need to adapt?
  - Observations and Analysis
- Why and how will it change?
  - Modelling and Analysis
- National scale climate services to users
- Science foundations for climate impacts studies, adaptation research and services.

Communicating the need for adaptation, getting the message out

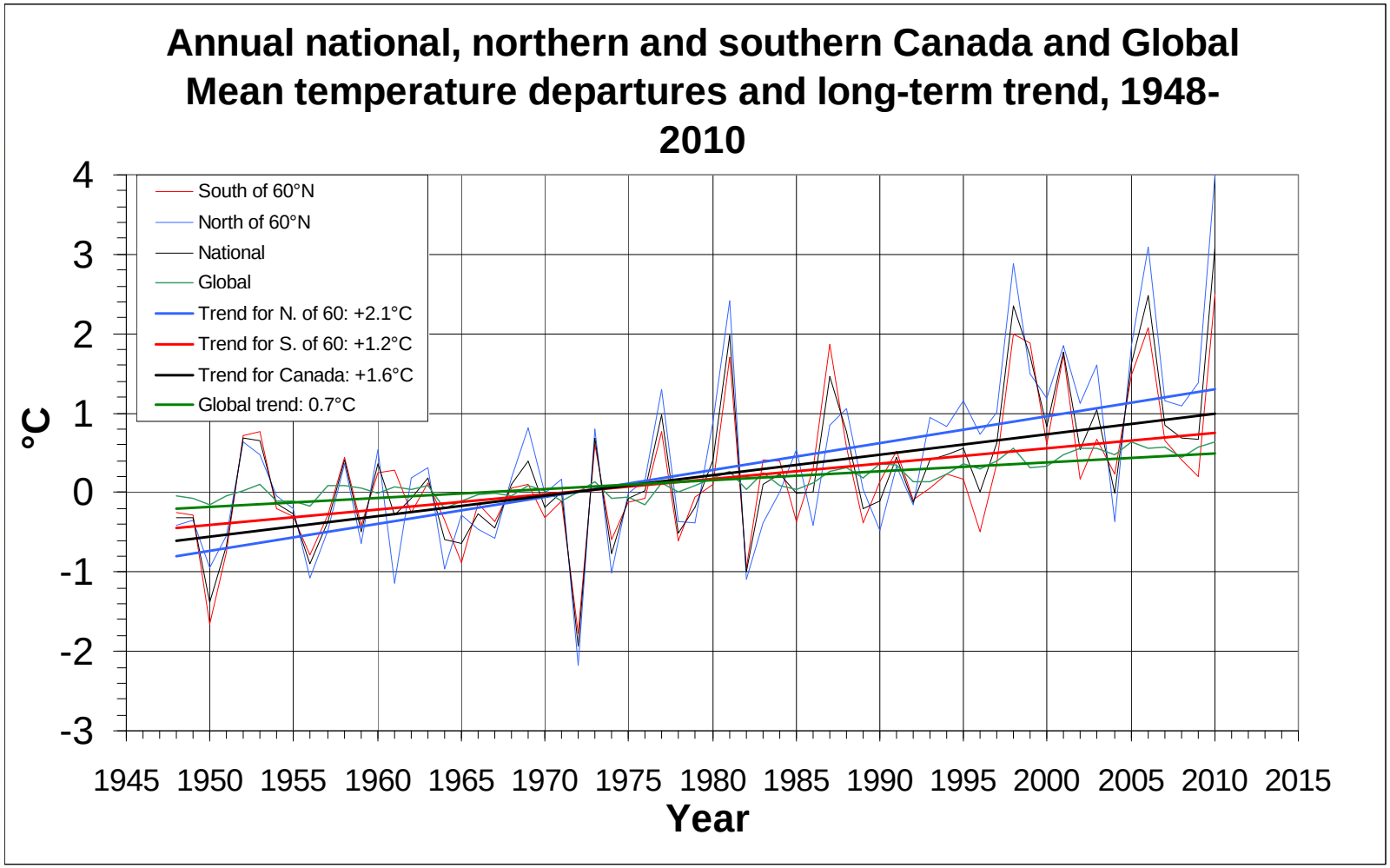
Part of EC's climate service is providing the monitoring and data analysis that quantifies changing climate.





EC: In IPCC AR4 WGII Figure 14.1

Canada, and the north, are warmer more than the global average.



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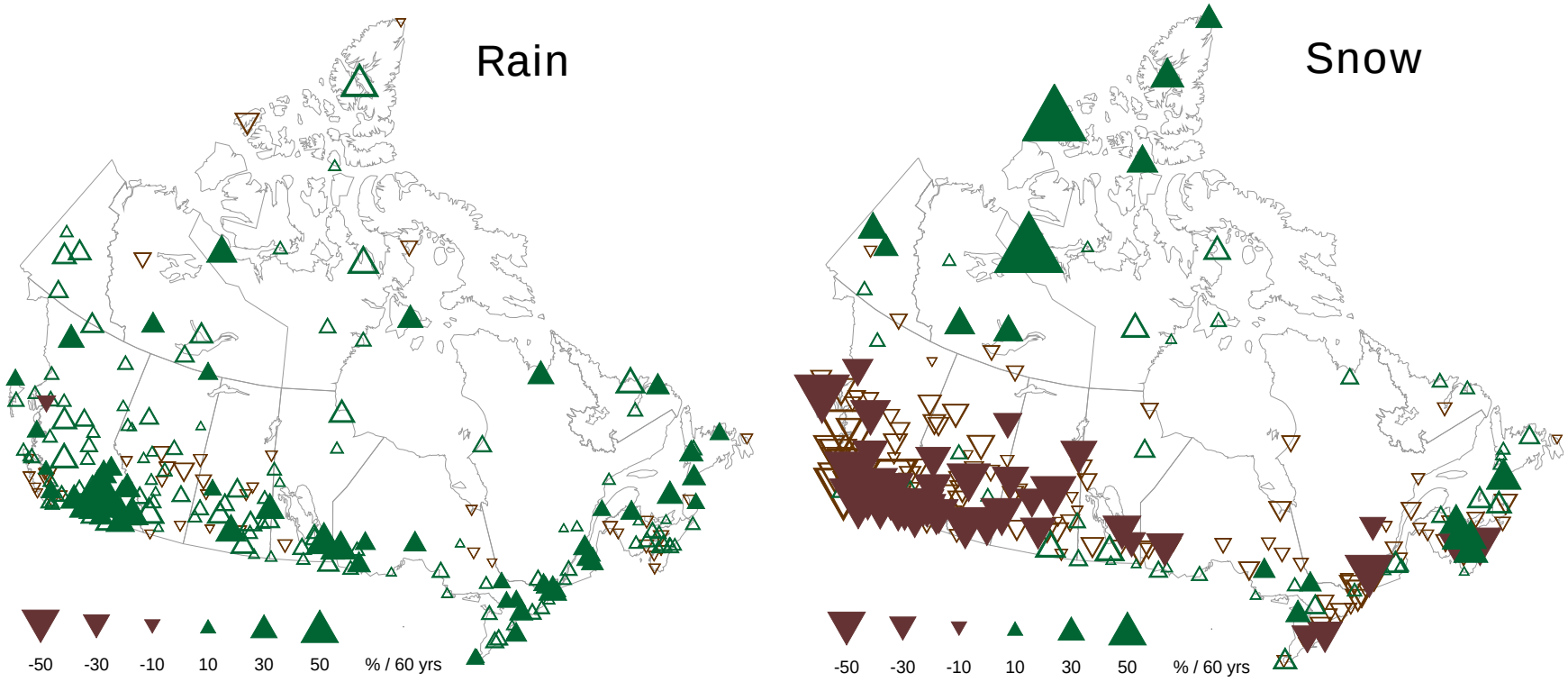
Precipitation patterns are shifting across Canada
Trends in annual rainfall / snow fall for 1950-2009



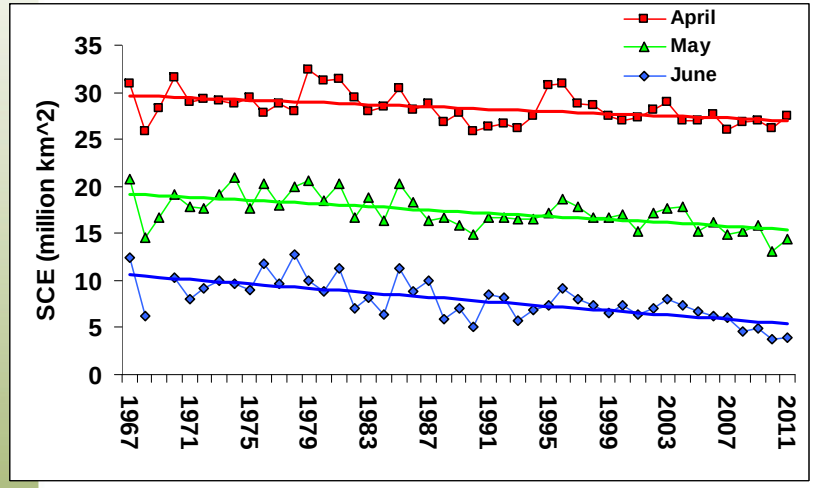
Rainfall has increased at most Candian locations over the past 60 years. Snowfall has increased in the north while a significant decrease was observed in the southwestern part of the country.

Upward and downward pointing triangles indicate positive and negative trends, respectively. Filled triangles correspond to trends significant at the 5% level. Percentage of normals are used. Mekis and Vincent, 2011

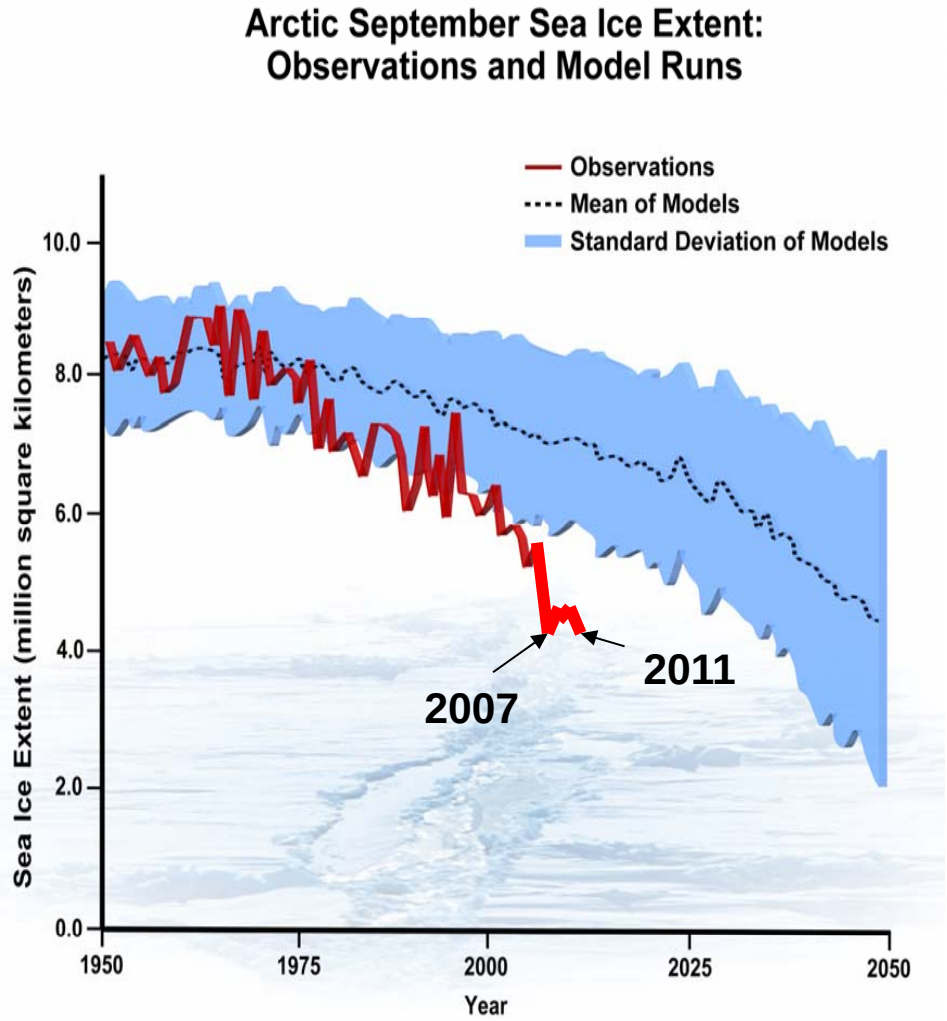
Trends and Variability in Arctic Snow Cover - Sea Ice 1979–2011

Implications for water resources, transportation, etc.

Snow Cover Extent



- Arctic warms
- Precipitation (snowfall) increases
- Snowpack depth increases
- Winter shortens, earlier spring
- Reduces areal extent of snow cover
- Increases/intensifies the high latitude water cycle
- Potentially higher spring runoff



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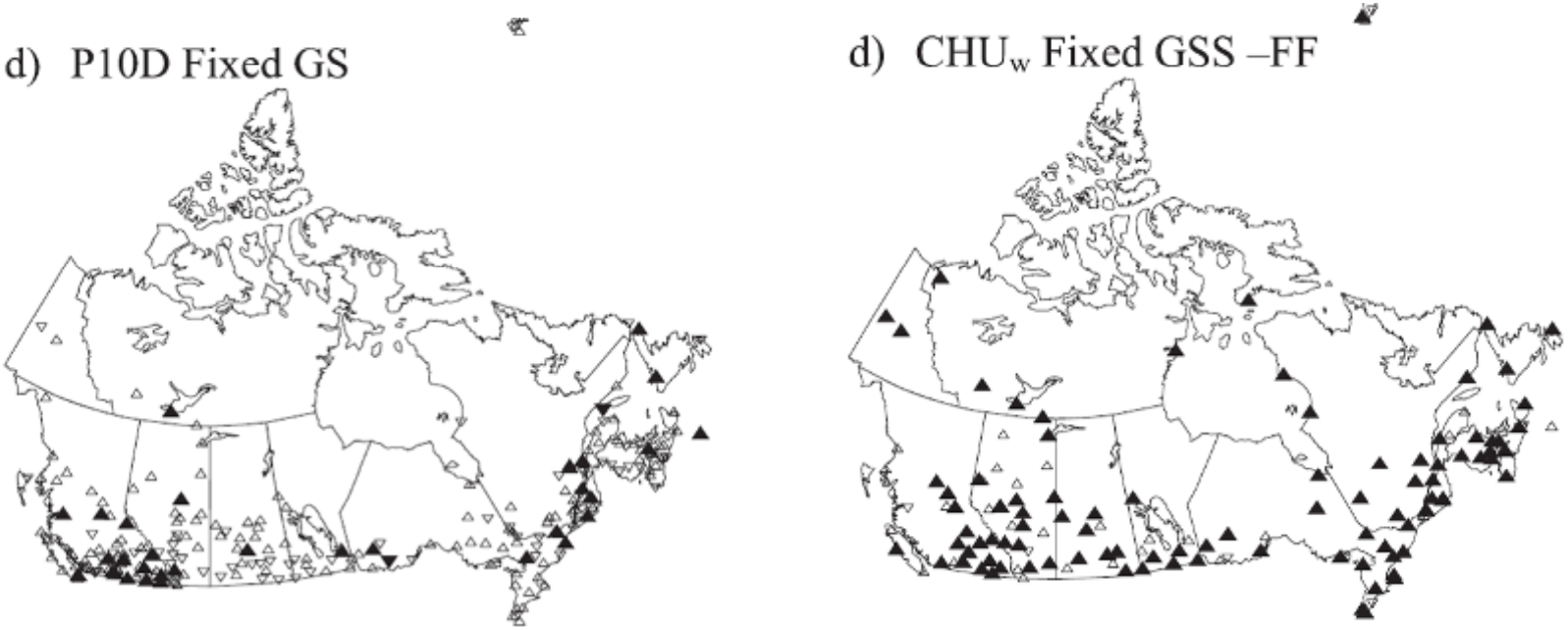
Sector specific: Working with federal departments
Long-Term Trends for Agro-climatic Conditions

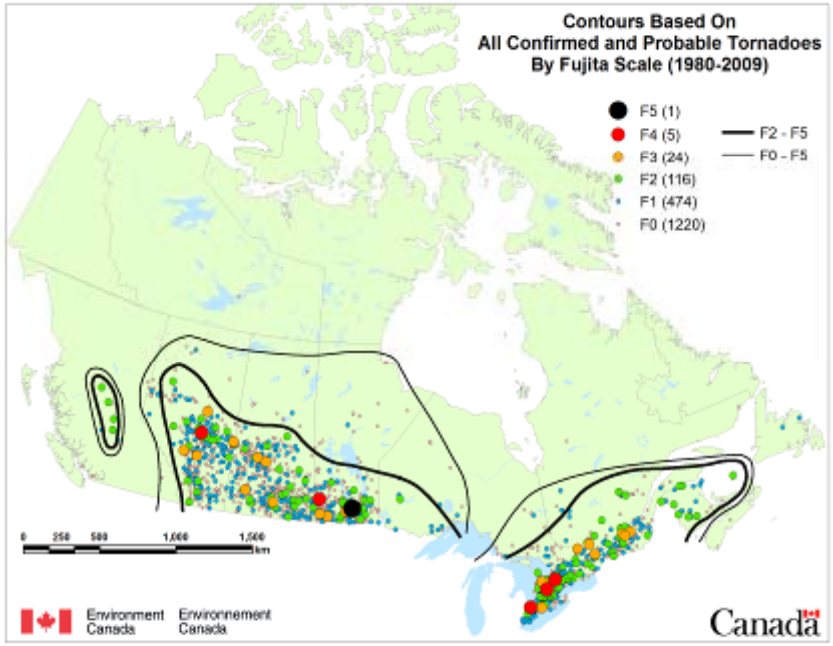
- B. Qian et al. J. of Applied Meteorology and Climatology, April 2010
- A set of agroclimatic indices representing Canadian climatic conditions for field crop production are analyzed for long-term trends during 1895–2007.
- A statistically significant increasing trend in the length of the growing season and in the associated available heat. The winter temperature is less damaging and the frost-free periods are longer. We also find trends in precipitation-related indices that indicate more availability of water, though the trend in the main agriculture region is less significant.

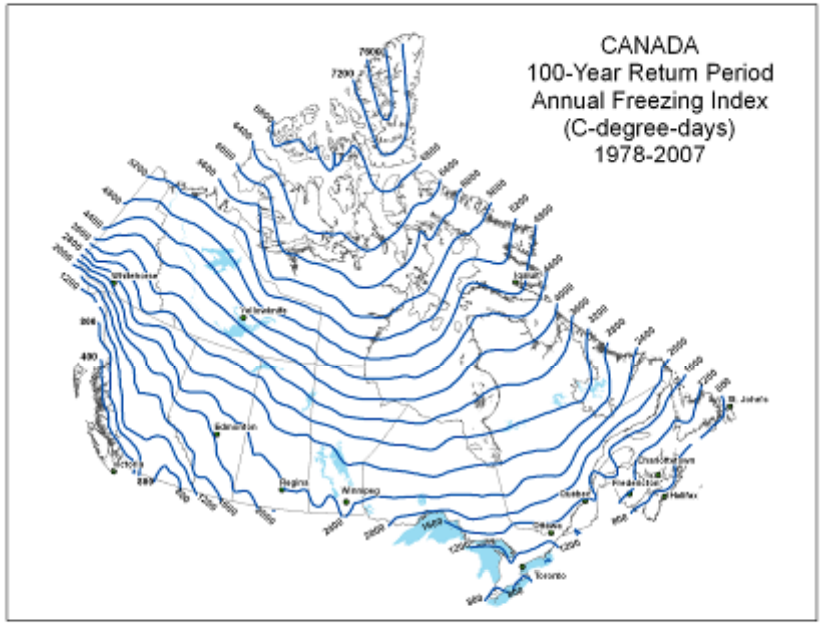


Trends in Consecutive 10-day Precipitation Total and Crop Heat Units, 1895 - 2007

Tailored products for infrastructure codes & standards: climatologies and extremes analysis

- Updates for standards in 2010
  - 9 of 15 climatic elements for 680 locations in the NBCC updated and expanded (first for wind since 1958)
  - New NBCC information for tornado prone areas and frost penetration
  - Update of ice/wind loads for the CSA transmission line standard (first since 1998 ice storm)
- Two new CSA Guides for Adaptation to Climate Change for Infrastructure in Permafrost and Rainfall IDF information for storm and waste water management
- Updates of EC IDF tables and graphs and related documentation





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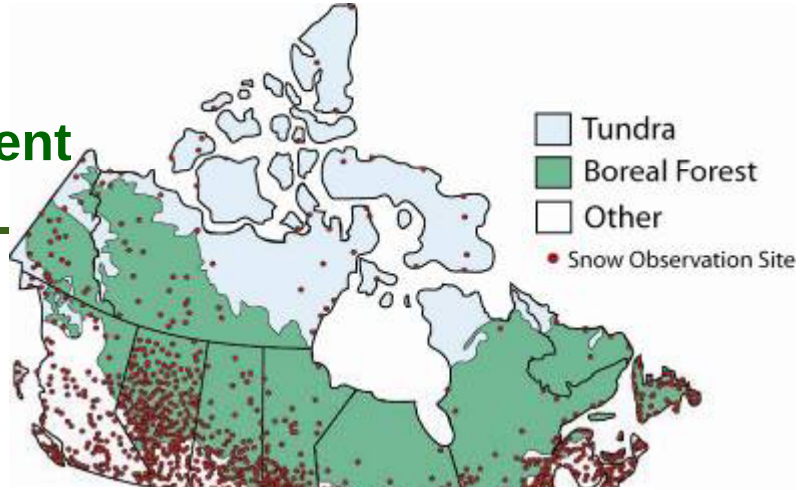
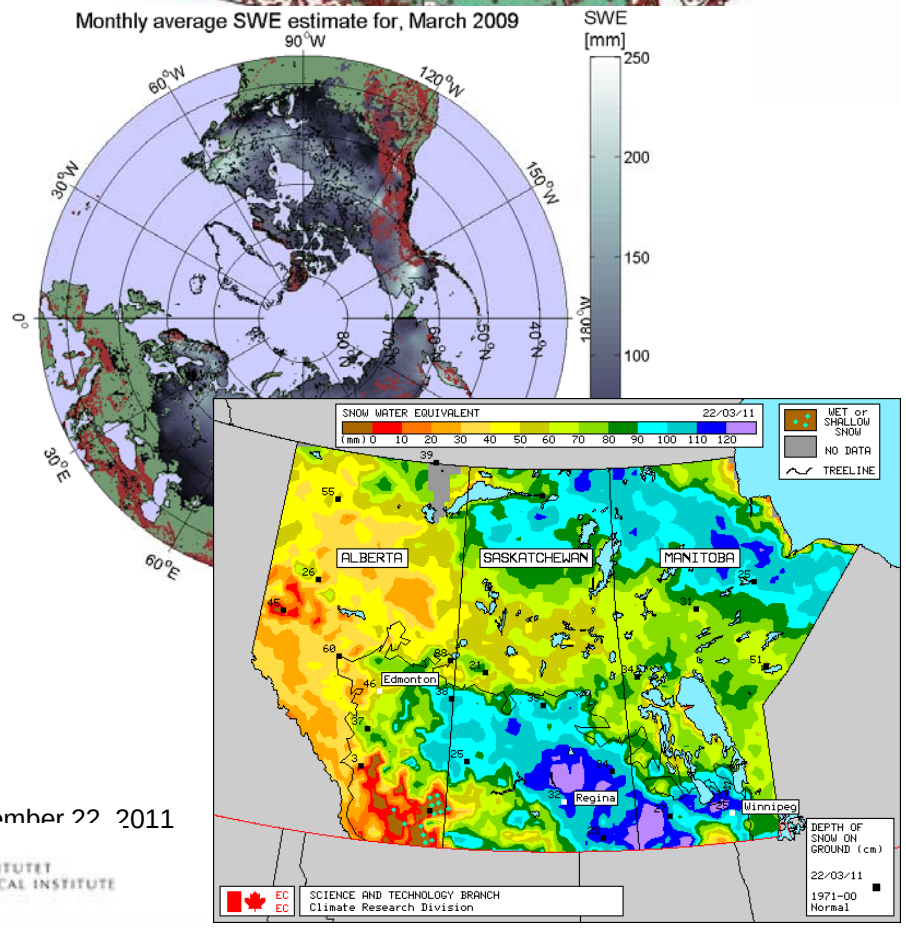
Information on Current Conditions: Satellite Derived Snow Water Equivalent

- Snow depth observing stations are sparse, necessitating satellite based solutions for snow monitoring.
- Multiple data sets (surface, satellite) are used to derive snow water equivalent (SW information over specific landscape region (prairies, boreal forest, tundra).
- Collaborative research with Finnish Meteorological Institute (FMI) and Europea Space Agency (GlobSnow project).
- Weekly SWE products for MSC, provinces and private sector support water management actions, and are used study response of ryosphere to climate variability and change.





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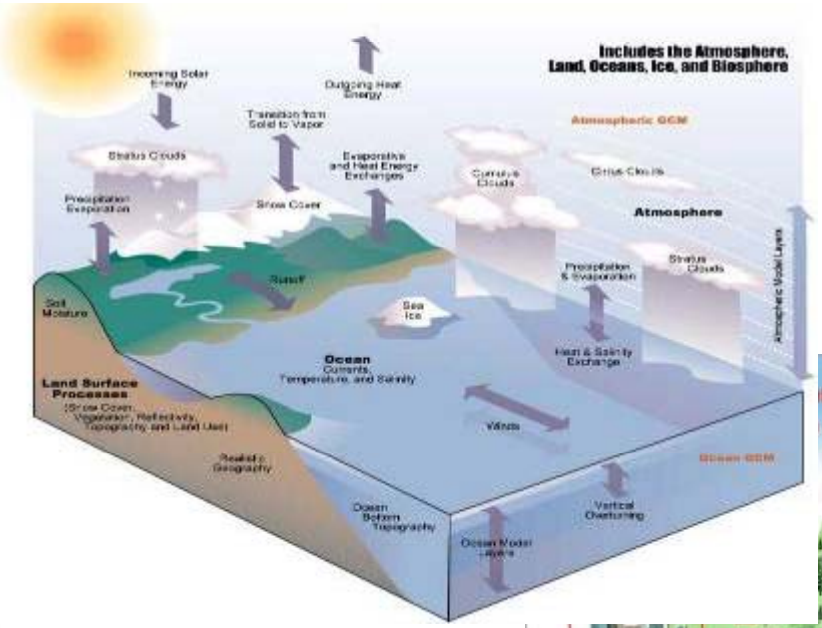
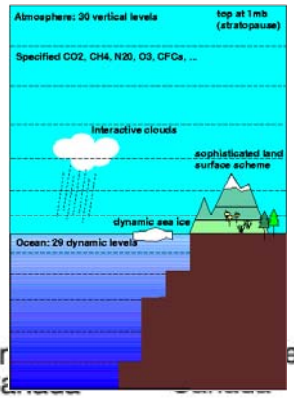
Providing information on future climate: the Canadian Earth System Model, CanESM

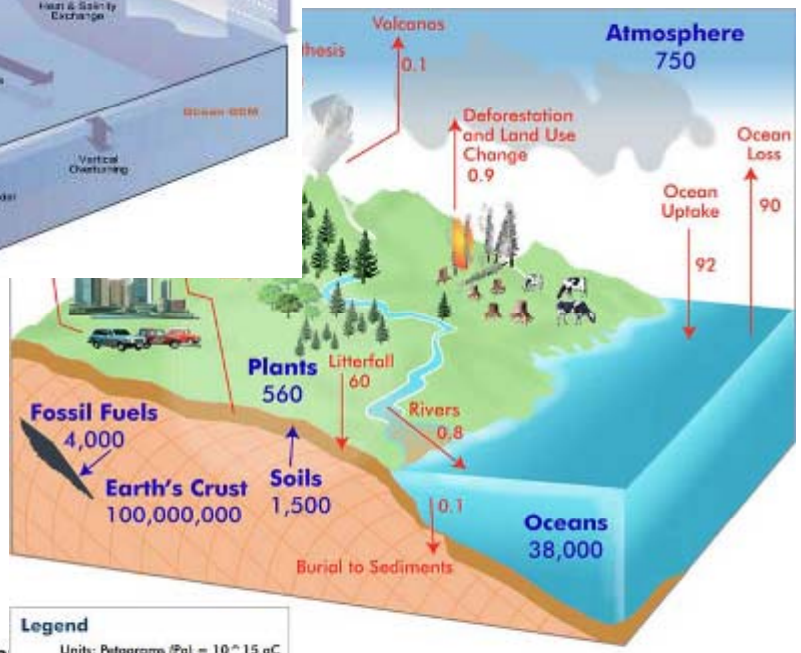
Includes the atmosphere, oceans, land surface, and cryosphere. Couples the physical climate system with relevant biogeochemical cycles, and lets these components interact over time in the model.



Specify GHG and aerosol emissions, along with land use change, to assist mitigation planning.

Predict climate parameters – means and extremes for temperature, precip, sea level, sea surface temp, etc.- for adaptation.





Global Carbon Cycle

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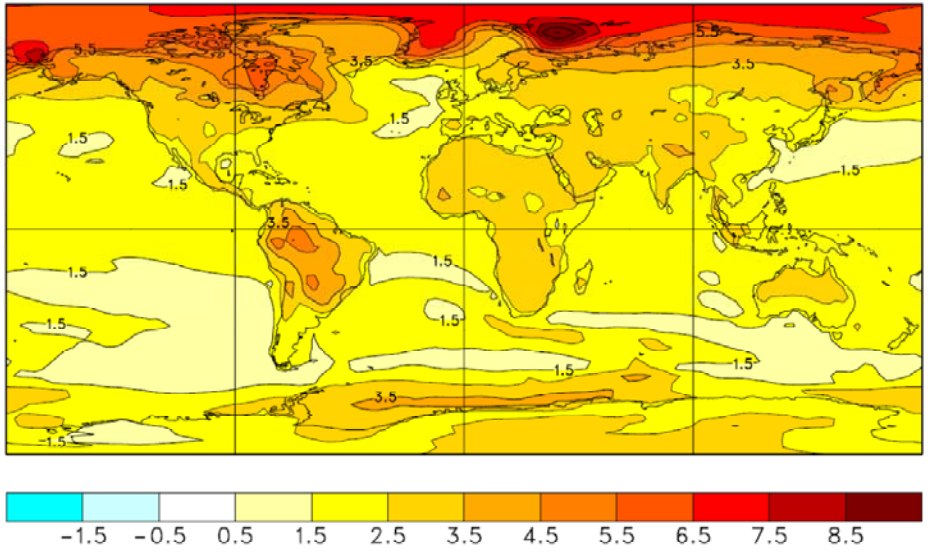
CanESM2 Global Results

Contributing to IPCC 5th Assessment, new model, CanESM2, makes use of 'Representative Concentration Pathways' (RCPs).

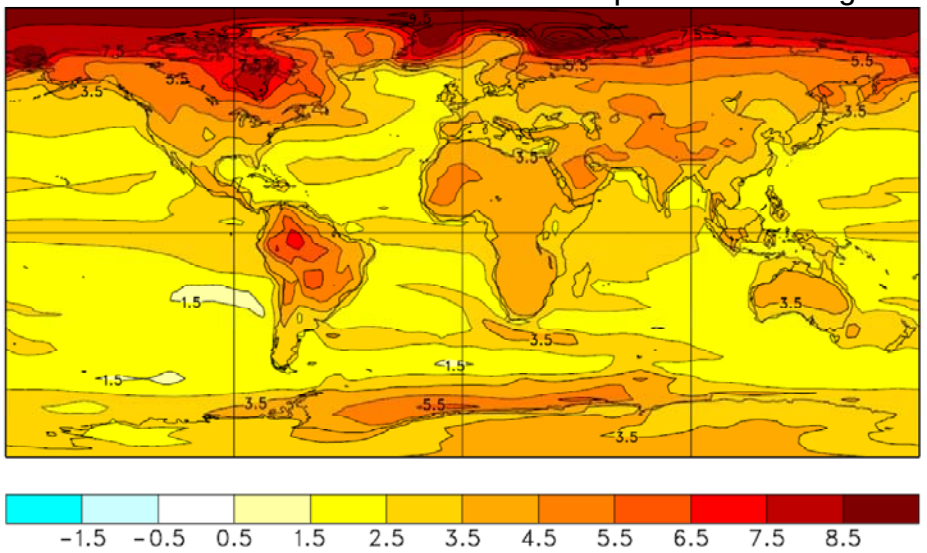
Projected warming is amplified at high northern latitudes, and greater over land surfaces than oceans.

RCP2.6: 2090-2100 surface air temperature change



Global: 2.3ºC Land: 3.0ºC
Canada: 4.0ºC Arctic: 5.0ºC

RCP4.5: 2090-2100 surface air temperature change



Global: 3.2ºC Land: 4.2ºC
Canada: 5.6ºC Arctic: 6.6ºC

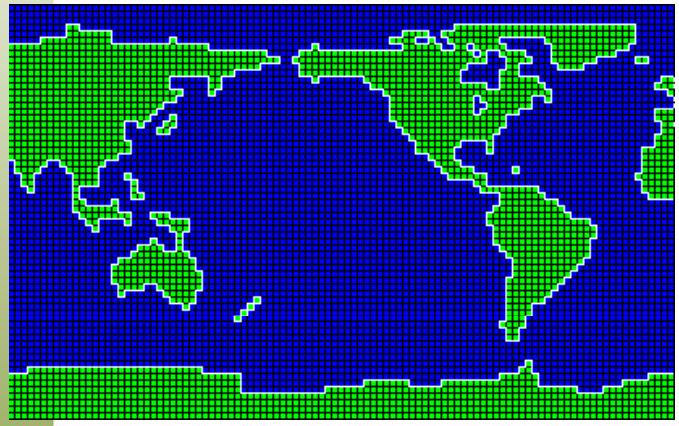
Seasonal to Inter-annual Prediction …

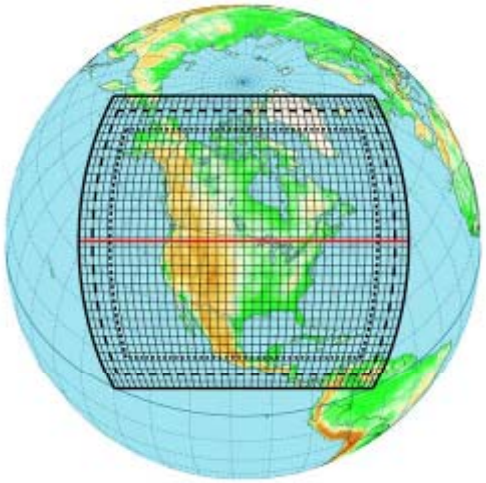
- The Canadian global coupled climate models are being developed for both long-term climate change projection, as well as seasonal to inter-annual (even decadal) climate prediction.
- Work over the last 3 years has allowed the capability to initialize the full 3-D climate system using observations, and then make climate predictions for a season, a year, and even a decade.
- The model is currently undergoing extensive testing to evaluate its skill.

Decadal Predictions of global, annual mean surface temperature (ºC)

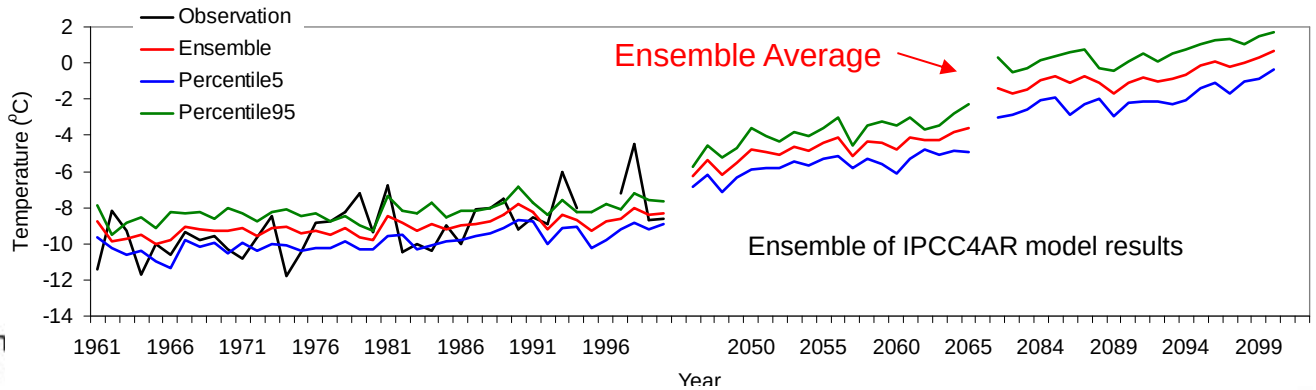
Downscaling, Regional Models and Scenarios

- ‘Downscaling’ – using regional models or statistical methods – to regional and local scales.
- The finer the space and time scale of downscaled products, the greater the uncertainties. Ensemble scenario rpducts integrate the results of multiple models / methods to provide a more robust prediction with uncertainty estimates.





Annual Mean Temperature in INUVIK (A2 1961-2000)



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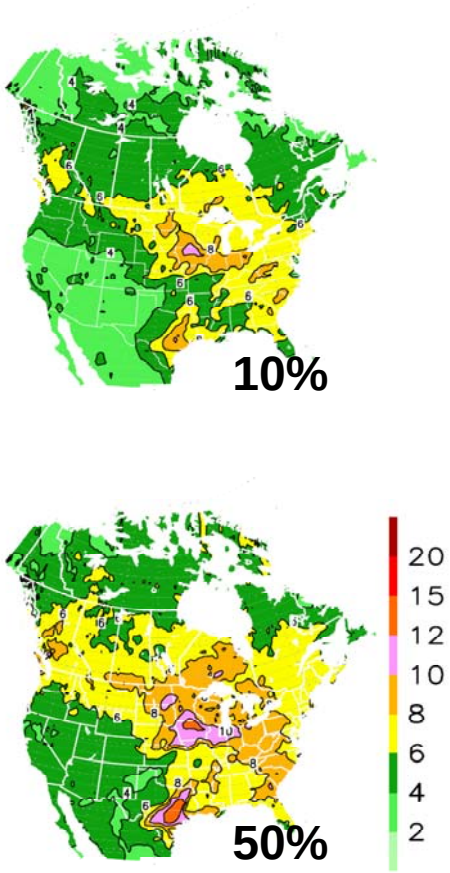
Extremes



Information required for adaptation is not always readily available from global climate model simulations. Very often, it is necessary to post-process such simulations using regional climate models (RCMs) or statistical methods to provide finer details or to infer specific information

Detailed projections (at 50 km resolution) of how the highest temperatures on the hottest day over 20-year may increase (in degree C) by middle of the 21st century. The 10-90% uncertainty range provides additional important information for planning adaptive responses to potential future extremes. These results were obtained by using a combination of RCMs and statistical methods (Li, Zhang, Zwiers, 2011 in preparation).

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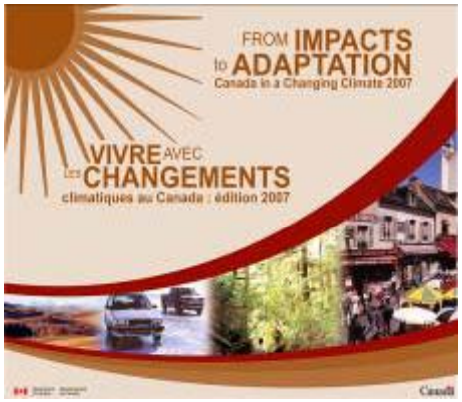
Environment Canada "climate services"

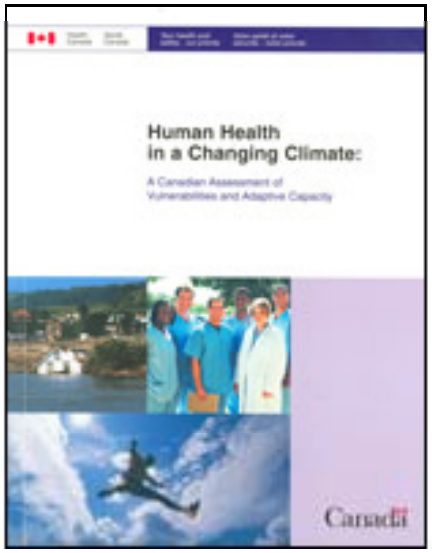
- **Providing national scale information or "climate services" which go directly and indirectly to users to support impact studies and adaptation research.**

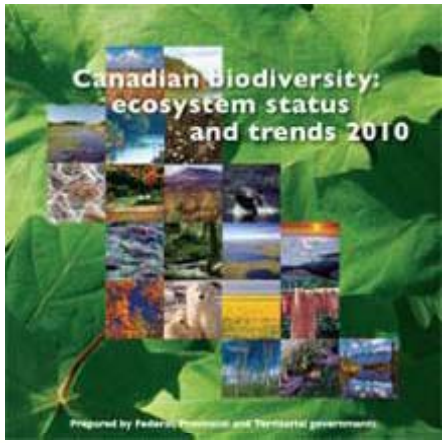
- Homogenized climate datasets, methodologies: www.ec.gc.ca/dccha-ahccd
- Global and regional climate model data: www.cccma.ec.gc.ca
- Scenarios and downscaling tools: www.cccsn.ca
- Climate Trends and Variations Bulletin: http://ec.gc.ca/adsc-cmda
- Snow Water Equivalent Maps: www.ccin.ca
- Climate Change Indicators with Statistics Canada
- >100 peer reviewed science publications per year
- Contributions to IPCC, Arctic Council, UNEP etc.

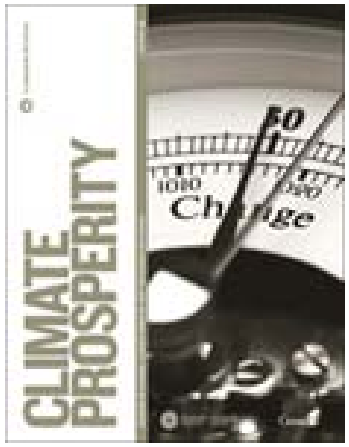
Informing Assessments on Climate Change Impacts

- NRCan “From Impacts to Adaptation: Canada in a Changing Climate”
- Health Canada “Human Health in a Changing Climate: A Canadian Assessment of Vulnerabilities and Adaptive Capacity”
- Federal, Provincial and Territorial Governments of Canada. Canadian Biodiversity: Ecosystem Status and Trends 2010. Canadian Councils of Resource Ministers. Ottawa, ON. 2010.
- NRTEE Climate Prosperity Reports 1 – 4, 2011







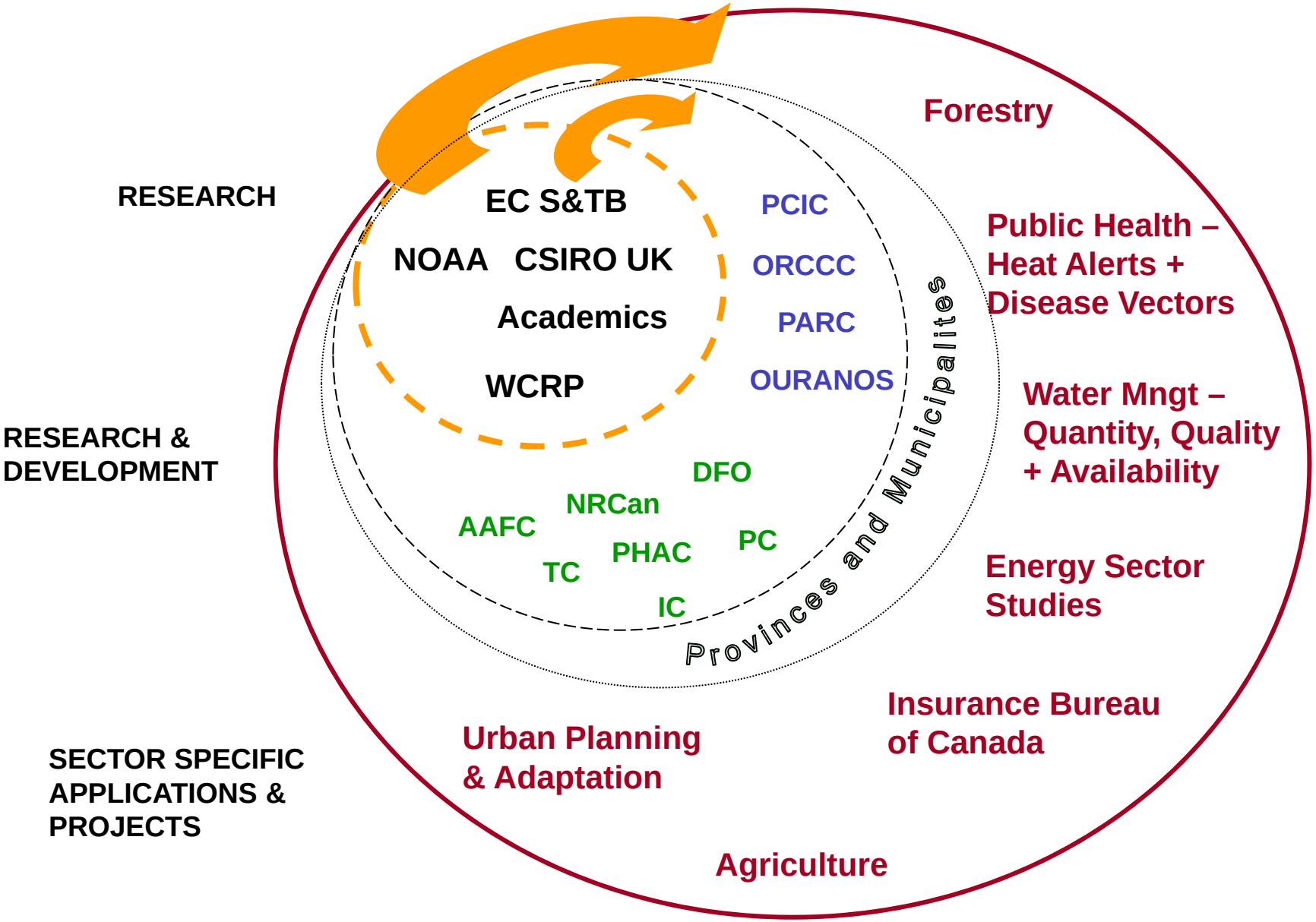


The Adaptation / Services Gap

- Between the “push info” and “pull info” functions
- Between climate science and the users

- Addressing the gap:
  - the applied science developed through close conversation between user and climate science expert to bring the right type of info at the right scale to the specific adaptation challenge.

- CESD Audit 2010: Undertake efforts to improve the coordination of provision of climate information, and to improve accessibility of information for users.



The boundaries are not distinct, and at various points all the players are partners