University of Saskatchewan
Global Institute for Water Security

The Changing Cold Regions Network

Large-scale modelling workshop

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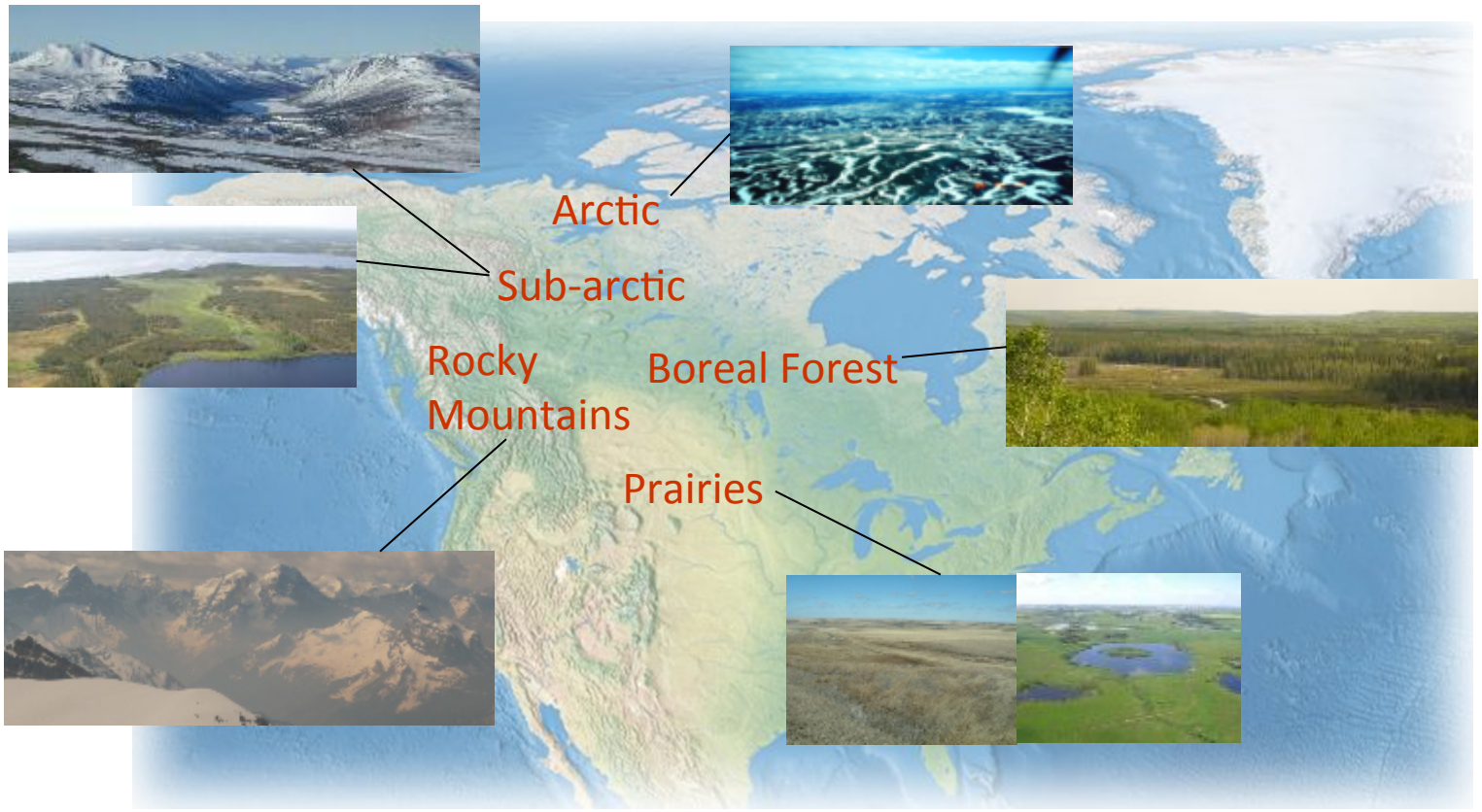
*This Network aims to **understand, diagnose and predict** interactions amongst the cryospheric, ecological, hydrological, and climatic components of **the changing Earth system** at multiple scales with a geographic focus on **Western Canada**'s rapidly changing cold interior.*

CCRN Research Programme

- Focused on Canada's western interior cold regions



The Network

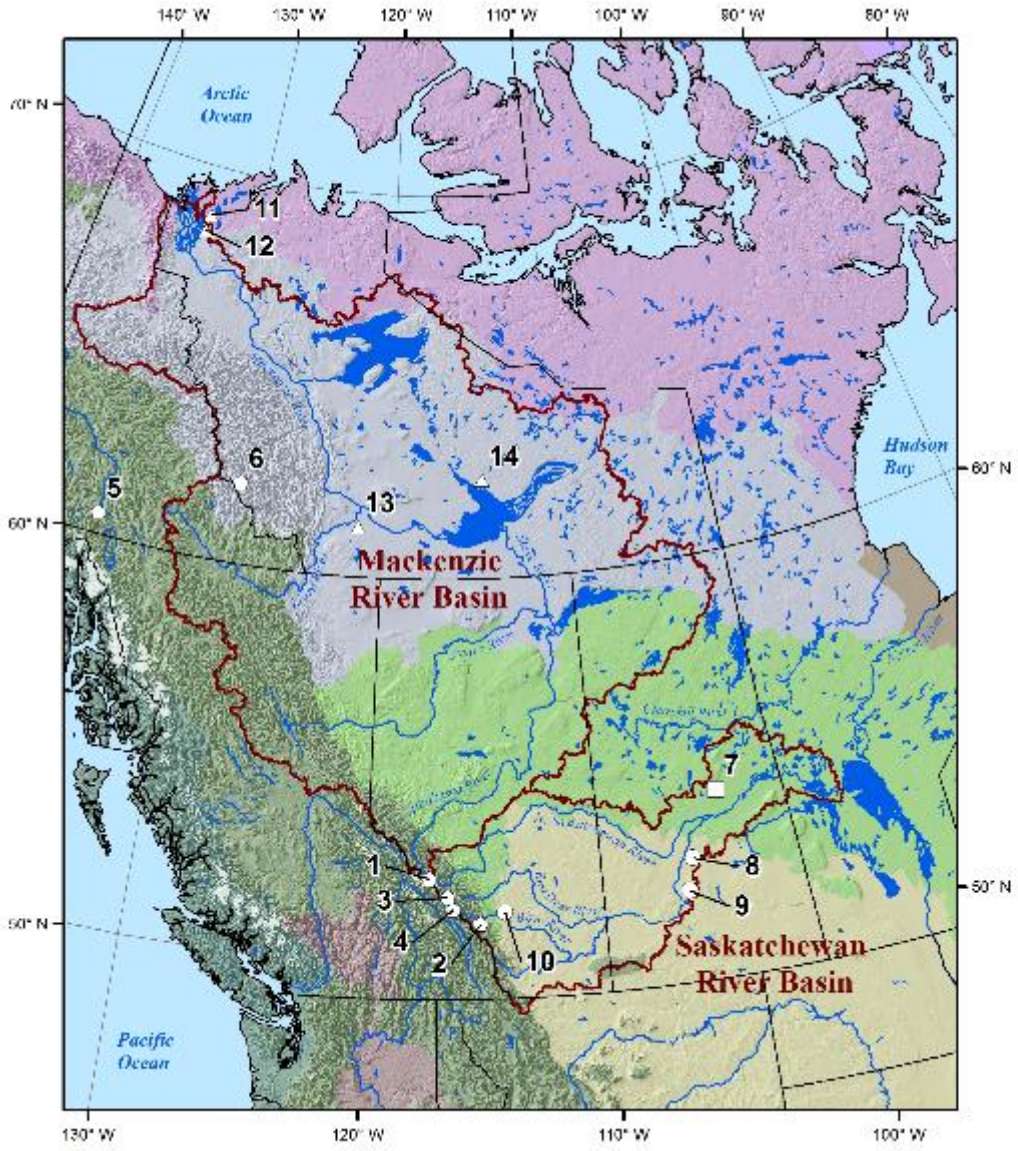
- Funded for 5 years under the NSERC CCAR Initiative
- Leveraging $24 million in-kind support
- Linked to GEWEX, CLiC, GEO, NCAR, NASA, and more
- 36 Canadian researchers
  - Additional researchers continuing to join Network
- 15 international collaborators (USA, China, UK, France, Germany)

Canadian Institutional Partners

- Canadian Universities
  - University of Saskatchewan
  - University of Calgary
  - University of Manitoba
  - University of British Columbia
  - Wilfrid Laurier University
  - McMaster University
  - University of Guelph
  - Université du Québec à Montréal
- Federal Government Partners
  - Environment Canada
  - Natural Resources Canada
  - Agriculture and Agri-Food Canada
  - Parks Canada
- Provincial and Territorial Government Agencies
  - Saskatchewan Water Security Agency
  - Government of Northwest Territories
  - Yukon Environment
  - Alberta Environment and Sustainable Resource Development
  - Government of Manitoba

International Partnerships and Synergies

- World Climate Research Program (GEWEX, CLiC) and Group on Earth Observations (GEO)
  - SaskRB is a GEWEX Regional Hydroclimate Project; CCRN is a proposed GEWEX RHP
  - 2 GEWEX GHP cross-cuts proposed, 1 MIP
- Collaboration with NCAR, NASA
  - AirMOSS, SMAP
  - Arctic-Boreal Vulnerability Experiment (ABoVE)
  - High res WRF simulations for SaskRB
- Participation in key initiatives
  - Circum-Arctic Environmental Observatories Network (CEON), Arctic Observing Network (AON), Circumpolar Active Layer Monitoring (CALM) Network



Changing Cold Regions Network Study Domain

Water, Ecosystem, Cryosphere and Climate Observatories

Western Cordillera

1: Columbia Icefield, AB
2: Marmot Creek Research Basin, AB
3: Wapta Icefield/Peyto Glacier, AB
4: Lake O'Hara, BC
5: Wolf Creek Research Basin, YT
6: Brintnell-Bologna Icefield, NWT

Boreal Forest

7: Boreal Ecosystem Research and Monitoring Sites (BERMS), White Gull Creek, SK

Prairie

8: St. Denis National Wildlife Area, SK
9: Kenaston/Brightwater Creek Mesonet Site, SK
10: West Nose Creek, AB

Sub-Arctic Lowlands

11: Trail Valley Creek, NWT
12: Havikpak Creek, NWT
13: Scotty Creek, NWT
14: Baker Creek, NWT

Ecoregions and Landcover

- Glaciers
- Tundra
- Taiga
- Hudson Plains
- Boreal Forest
- Northwestern Forested Mountains
- Marine West Coast Forest
- Great Plains
- North American Deserts

0 250 500 km

Water, Ecosystem, Cryosphere and Climate (WECC) Observatories

- A network of WECC Observatories combine meteorological, hydrological, ecosystem, and cryospheric observations with multi-scale coupled models from the surface to the atmosphere.

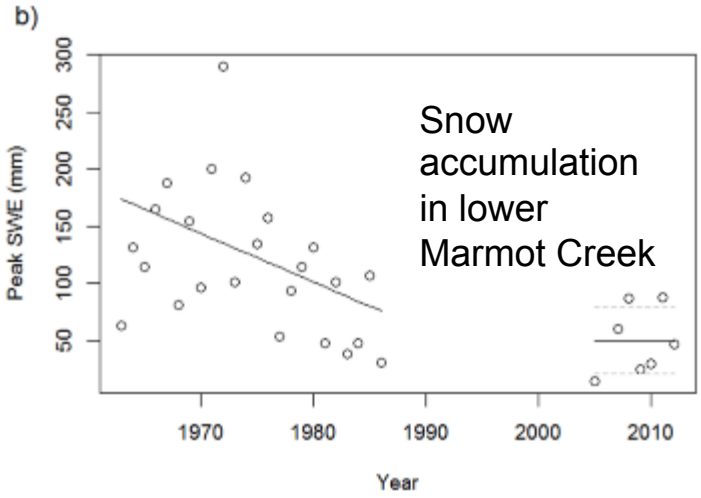



CCRN Research Programme: Thematic Approach

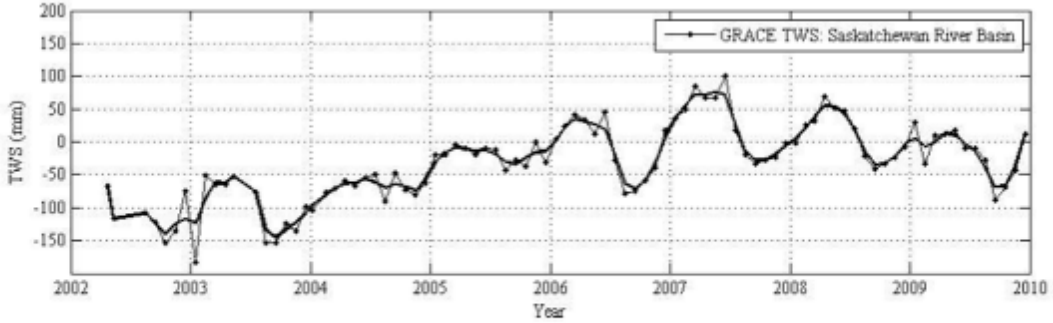
A. Observed Earth System Change in Cold Regions - inventory and statistical evaluation
B. Improved Understanding and Diagnosis of Local Scale Change
C. Upscaling for improved Atmospheric Modelling and River Basin Scale Prediction
D. Analysis and Prediction of Regional and Large Scale Variability and Change
E. Outreach and Engagement

Theme A: Observed Change

- How have the hydrological, ecological, cryospheric and atmospheric components of the Earth system changed over the last 30 years in response to climate warming?
- What are the collective large scale trends and variability of the Earth system?
  - Local scale
  - Biome to regional scale



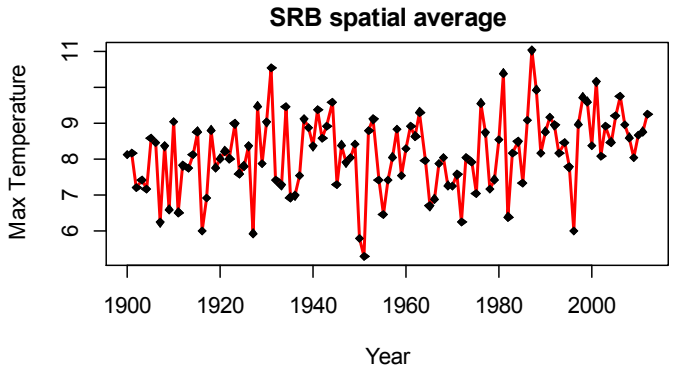
Snow accumulation in lower Marmot Creek

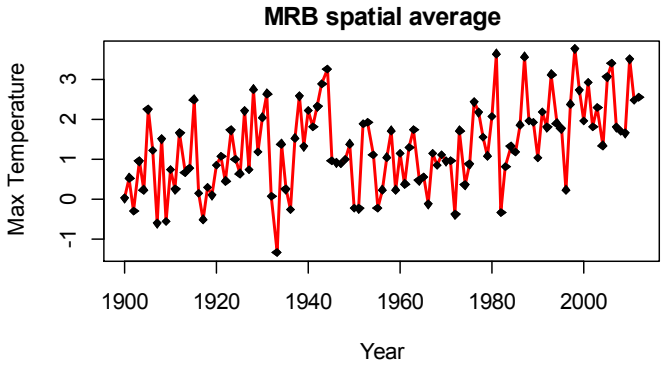


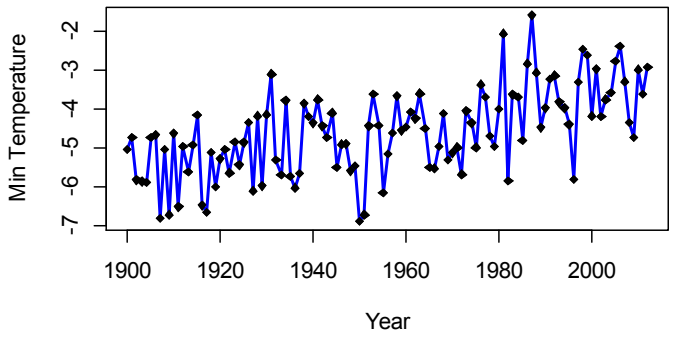
Water storage in Saskatchewan River Basin

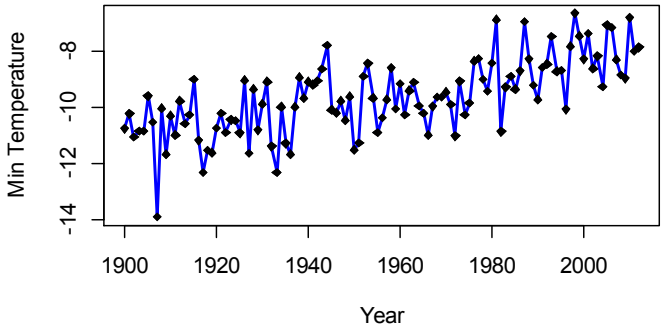
Figure 10. GRACE total water storage (TWS) changes over two water drainage basins shown in Fig. 9 relative to the mean over the period 2005 to 2009.

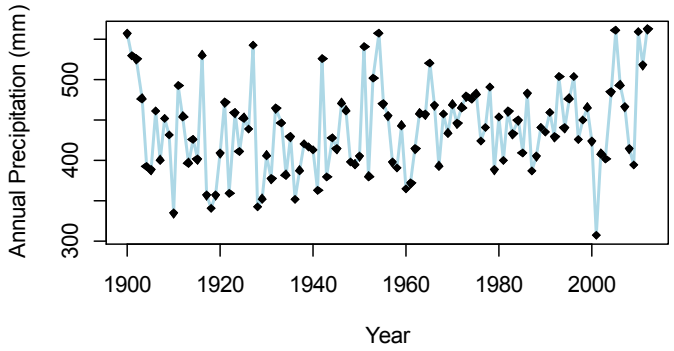
Basin-averaged time series - CANGRID

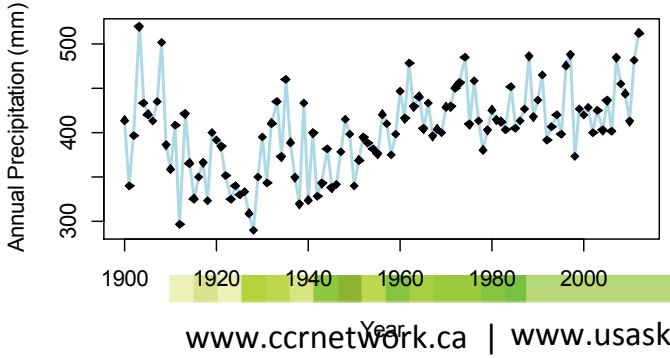






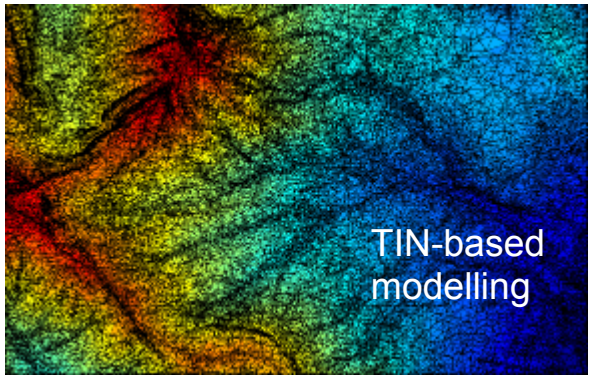


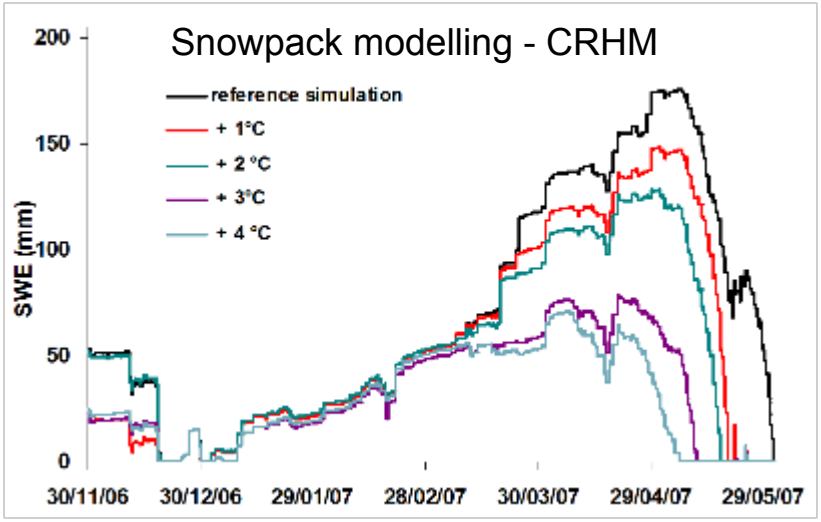




Theme B: Diagnosis of Local Scale Change

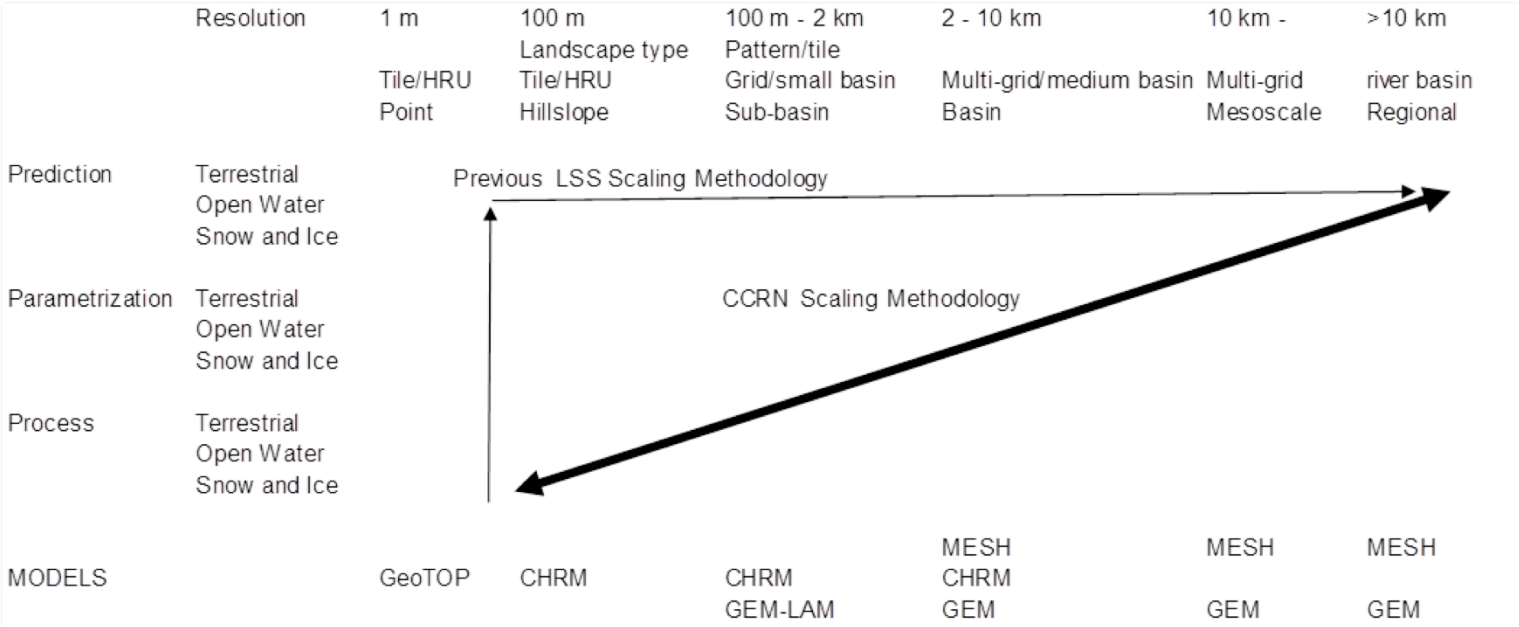
- How have interacting Earth system processes changed in response to changing climate?
- How can fine-scale process models be improved to better diagnose for key factors governing change?;
- What are the interactions amongst climatic, hydrological, ecological and cryospheric drivers, processes and feedbacks, and thresholds leading to system changes at local scales?
  - Process studies
  - Improved local scale models
  - Diagnosis of past changes





Theme C: Upscaling Models for Prediction

- How can our large-scale predictive models be improved to better account for the changing Earth system and its atmospheric feedbacks?
  - Land surface model development and testing
  - Large scale hydrological model development and testing

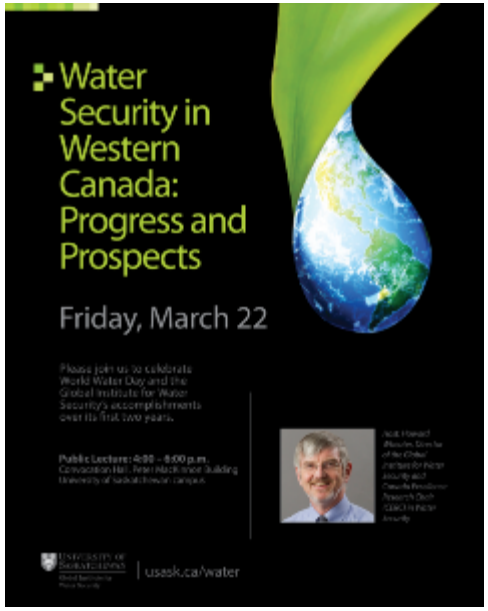


Theme D: Analysis and Prediction of Large Scale Change

- What governs the observed trends and variability in large-scale aspects of the Earth system and how well are these factors and effects represented in current models?
- What are the projected regional scale effects of Earth system change on climate, land and water resources?
  - Large scale land surface and climate controls
  - Changing climate, land surface and large scale hydrology
  - Atmospheric circulations, temperature and precipitation
  - Water resources, cryosphere and ecosystems

Theme E: Outreach and Engagement

- How do we apply and transfer our results to government and other stakeholders?
  - User community workshops,
  - Popular science articles in the public media,
  - Development of short-courses on predictive tools and other issues



The Future

- Over the next five years, CCRN will:
  - Improve our understanding of recent Earth system change in the cold interior of western and northern Canada
  - Advance water, weather, climate and environmental prediction
  - Improve our understanding of Earth system processes and their representation in hydrological, atmospheric and ecological models
    - Enhance our capability for water management
    - Train the next generation of Earth System Scientists
    - Provide high quality datasets for change assessment and model verification

CCRN Participants

Network Investigators and Collaborators

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- David Livingstone (GNWT, ret.)
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International Advisory Committee

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- Richard Harding (UK Centre Ecology and Hydrology)
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