The Changing Cold Regions Network:
Observation, Diagnosis, and Prediction of Environmental Change in the Saskatchewan and Mackenzie River Basins

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www.ccrnetwork.ca

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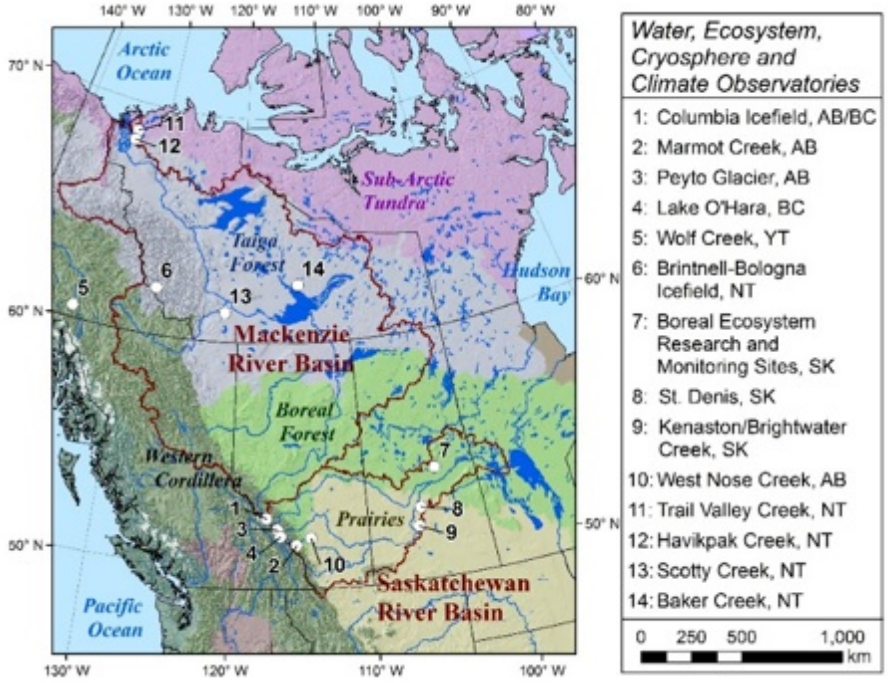
The RHP Story

- Following a workshop held in Saskatoon in March 2011, the Saskatchewan River Basin (SaskRB) RHP was initiated
- In December 2014, CCRN was endorsed as an RHP, expanding the focus to the Mackenzie and Saskatchewan Basins



CCRN: Changing Cold Regions Network

Funded by the Natural Sciences and Engineering Research Council of Canada's (NSERC's) Climate Change and Atmospheric Research (CCAR) initiative over 2013–2018

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NSERC
CRSNG

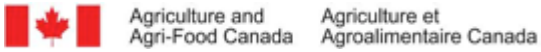
"This Network aims to ***understand, diagnose and predict*** *interactions amongst the cryospheric, ecological, hydrological, and climatic components of* ***the changing Earth system*** *at multiple scales with a geographic focus on* ***Western Canada's rapidly changing cold interior***."

CCRN: Changing Cold Regions Network

- Funded for 5 years (2013–2018) under the NSERC Climate Change and Atmospheric Research (CCAR) Initiative
- Leveraging $24 million in-kind support
- Strongly linked to GEWEX, NCAR, NASA, and more
- Builds on a strong legacy of past Canadian and international research initiatives

CCRN: Changing Cold Regions Network

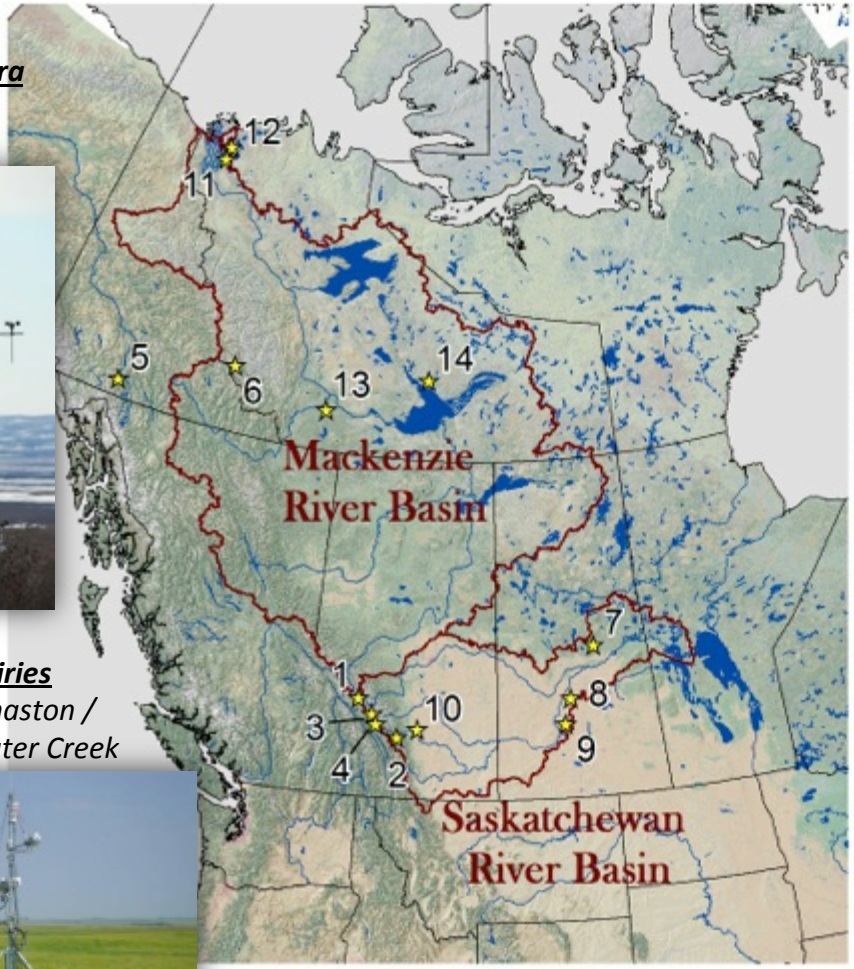
Led by Professor Howard Wheater, Canada Excellence Research Chair in Water Security at U of S, the Network includes 43 researchers from eight Canadian universities and four federal government departments



CCRN Research and Field Observatories

Sub-Arctic Tundra
#11: Trail Valley Creek

Prairies
#9: Kenaston / Brightwater Creek



Water, Ecosystem, Cryosphere, and Climate (WECC) Observatories

1. Columbia Icefield, AB
2. Marmot Creek, AB
3. Peyto Glacier, AB
4. Lake O'Hara, BC
5. Wolf Creek, YT
6. Brintnell Glacier, NT
7. BERMS, SK
8. St. Denis, SK
9. Brightwater Creek, SK
10. West Nose Creek, AB
11. Trail Valley Creek, NT
12. Havikpak Creek, NT
13. Scotty Creek, NT
14. Baker Creek, NT

Western Cordillera
#6: Brintnell-Bologna Glacier

Boreal Forest
#7: BERMS—Black Spruce

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CCRN Research: Thematic Approach

Theme A: Observed Earth System Change in Cold Regions - Inventory and Statistical evaluation

Theme B: Improved Understanding and Diagnosis of Local Scale Change

Theme C: Upscaling for improved Atmospheric Modelling and River Basin Scale Prediction

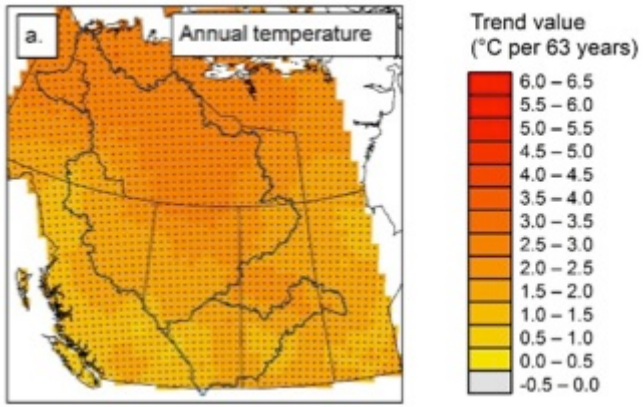
Theme D: Analysis and Prediction of Regional and Large Scale Variability and Change

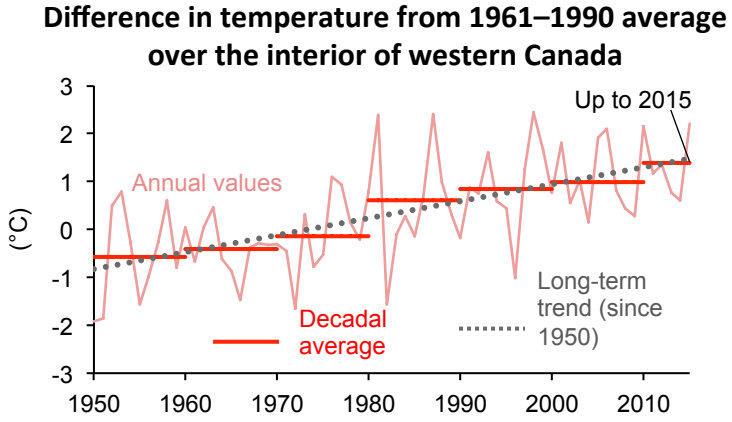
Theme E: User Community Outreach and Engagement

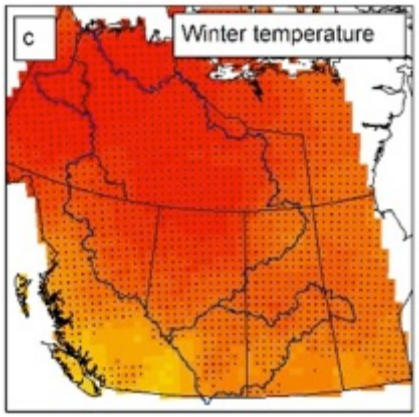
Activities and Progress

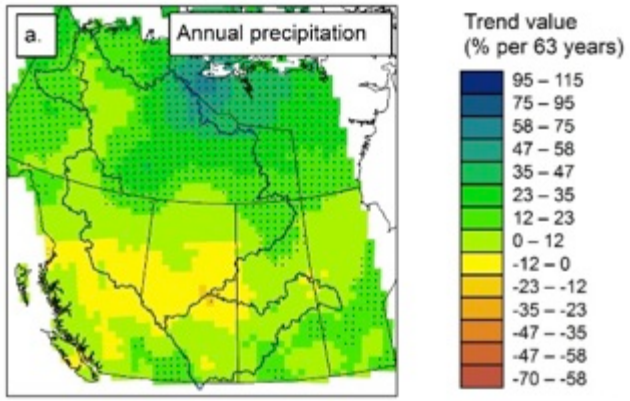
- Observed Earth system change in western Canada and scenarios of future change for incorporation into models

Climate trends (1950–2012)









Activities and Progress

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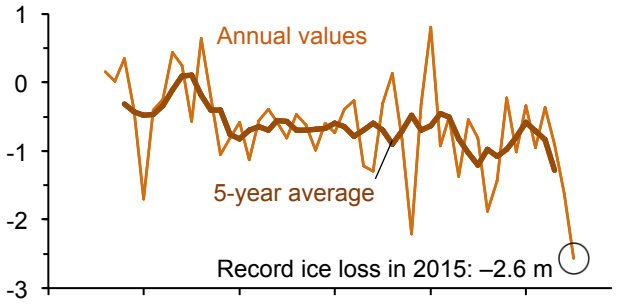
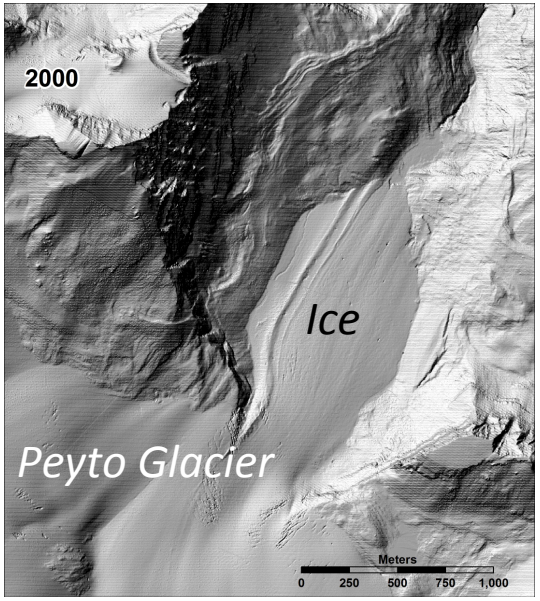
Retreat of the Peyto Glacier, AB

Mass balance record since 1965 for Peyto Glacier





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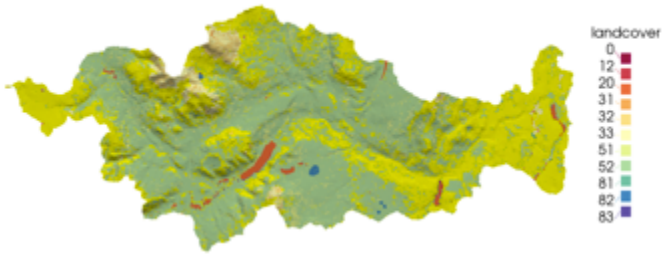
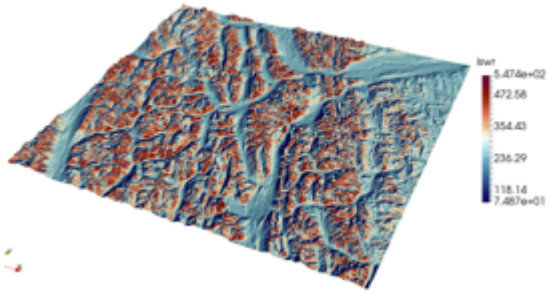
Activities and Progress

- Fine scale model advances and process representation with the Cold Regions Hydrological Model (CRHM)
- Enhanced computational efficiency and landscape representation within the next generation Canadian Hydrological Model (CHM)

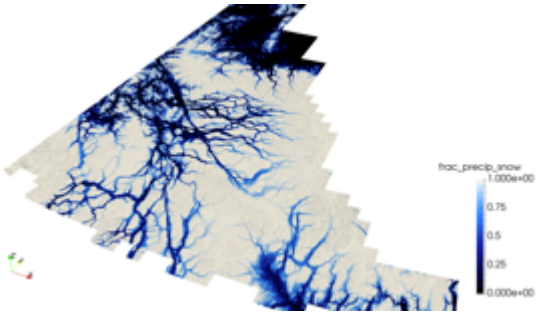
Basin (100 km^2)



Regional (8000 km^2)



Provincial (500 000 km^2)



Activities and Progress

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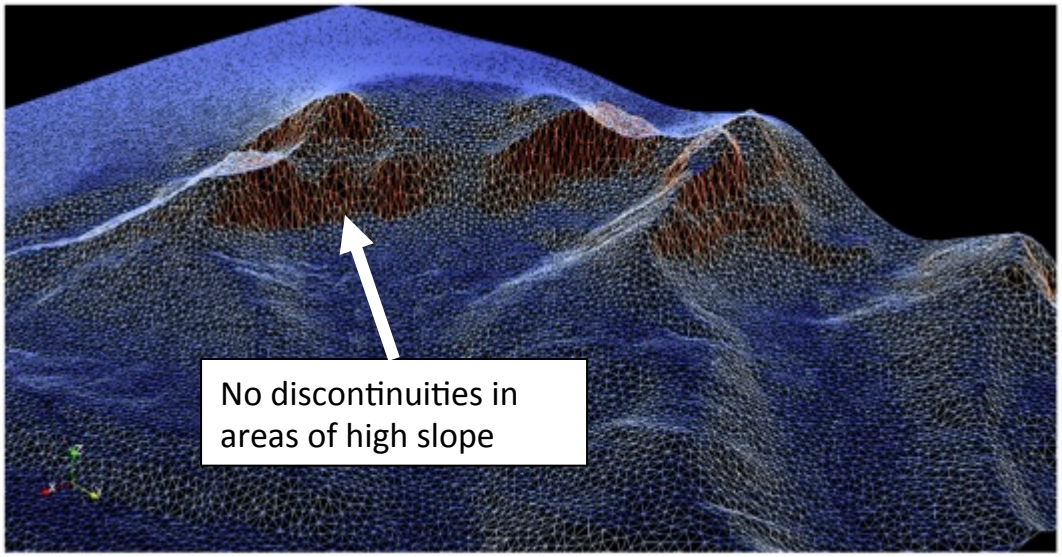
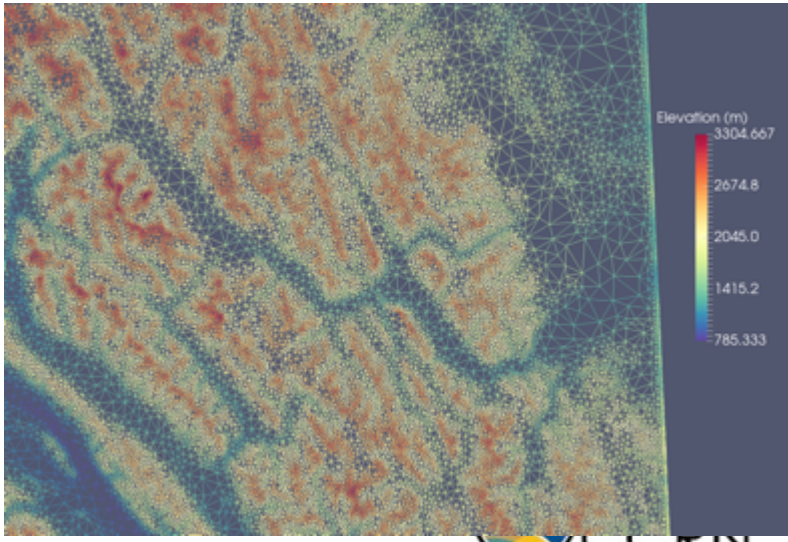
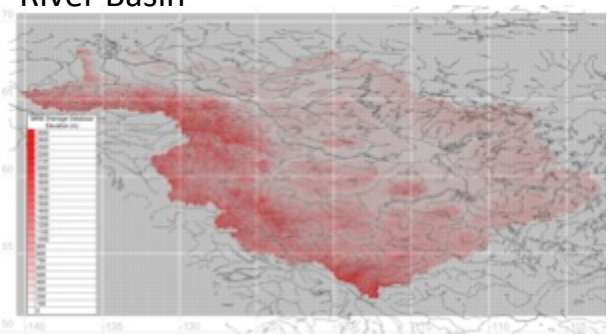




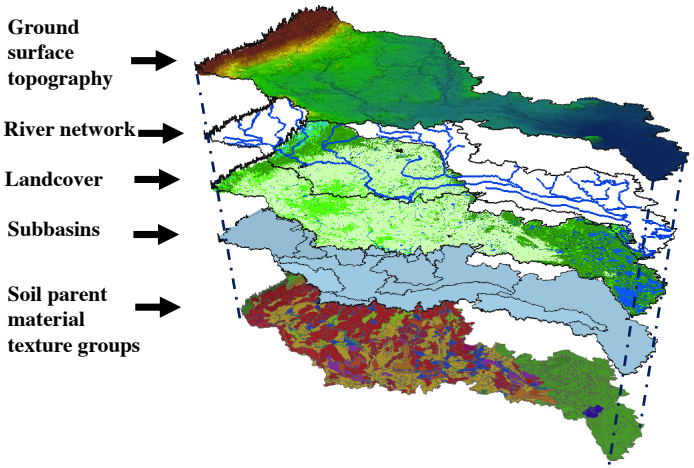
Activities and Progress

- In close collaboration with our partner, *Environment and Climate Change Canada*, improved large-scale models of the Saskatchewan and Mackenzie River Systems
  - Improvements to Canadian LAnd Surface Scheme (CLASS),
  - Modélisation Environmentale Communautaire (MEC) – Surface and Hydrology (MESH),
  - Canadian Terrestrial Ecosystem Model (CTEM)

MESH model set up for the Mackenzie River Basin



19,598 grid cells, 8 GRUs, 1.755 M Km^2



MESH model set up for the Saskatchewan River Basin

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Activities and Progress

- In collaboration with NCAR, we have generated 4 km resolution WRF climate simulations (2001–15) and pseudo-global warming (2086–2100)

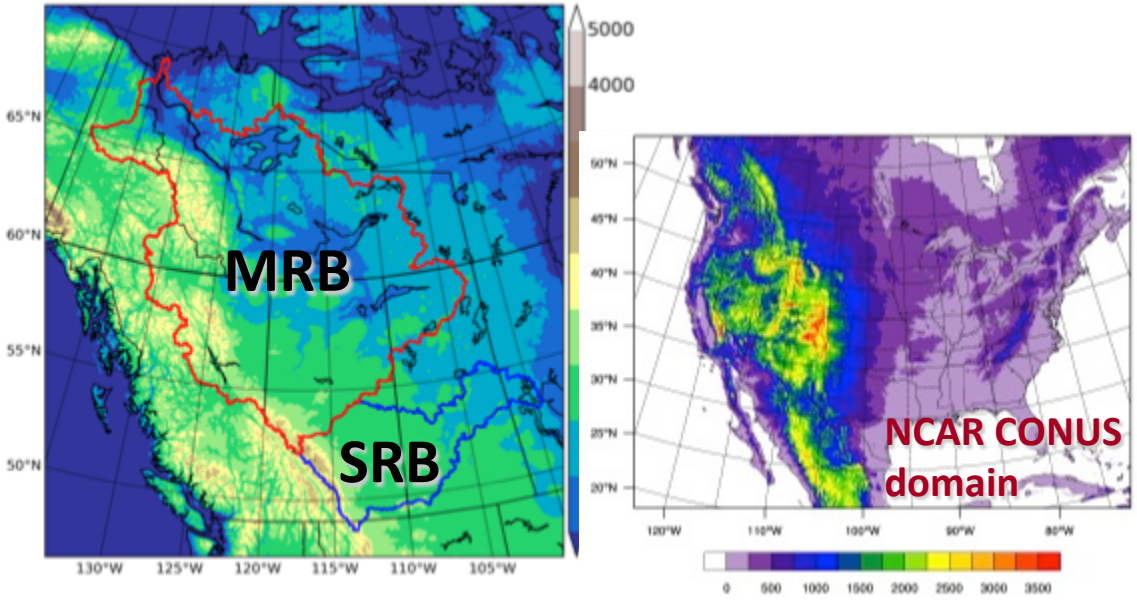
WRF Model Setup and Design

- WRF Model (Version 3.4.1)
- A single domain: 2560 x 2800 km^2;

  4 km grid spacing; 37 levels
- Microphysics Scheme: New Thompson et al.
- PBL scheme: YSU
- RRTMG Long-wave and Short-wave scheme
- No Cumulus parameterization used, assumed explicit

Forcing Data

- The 6-hourly, 0.703^0 x 0.703^0 resolution ERA-Interim reanalysis data provide the initial and lateral boundary condition



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Activities and Progress

- Multi-disciplinary and in-depth examination of recent extreme events in western Canada

Flooding in Calgary and Canmore Alberta, June 2013 (Images: Johnathan Hayward/The Canadian Press; Rocky Mountain Outlook/Craig Douce)

Wildfire in Fort McMurray, May 2016 (Image: Johnathan Hayward/The Canadian Press)

Drought across western Canada, spring/ summer 2015 (Image: Alberta Farmer Express, Bill Neufeld)

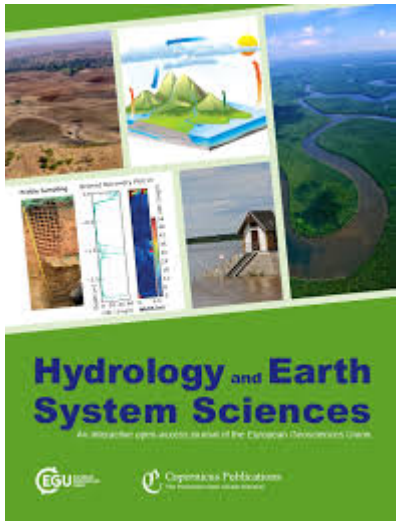
Activities and Progress

- Multi-disciplinary and in-depth examination of recent extreme events in western Canada

Focal Examination of 2013 floods *See the CCRN homepage for detailed info, links to papers, media coverage, and information products*

Activities and Progress

- CCRN has opened two special issues in ESSD and HESS. These can be found at:
  - www.earth-syst-sci-data.net/special_issue901.html and,
  - www.hydrol-earth-syst-sci.net/special_issue919.html



Upcoming Activities

- We have two key workshops coming up this fall and winter http://www.ccrnetwork.ca/science/workshops

  - Modelling Future Earth system change workshop
    - November 2–3, 2017, Canmore, AB, Canada
    - Purpose: review diagnostic and predictive model runs over the Saskatchewan and Mackenzie Basins, plan final runs for CCRN, develop papers and products
  - CCRN Finale
    - March 5–7, 2018, Saskatoon, SK, Canada
    - Purpose: review and synthesize CCRN's scientific achievements and look to the future in follow on initiatives

GLOBAL WATER FUTURES

SOLUTIONS TO WATER THREATS IN AN ERA OF GLOBAL CHANGE

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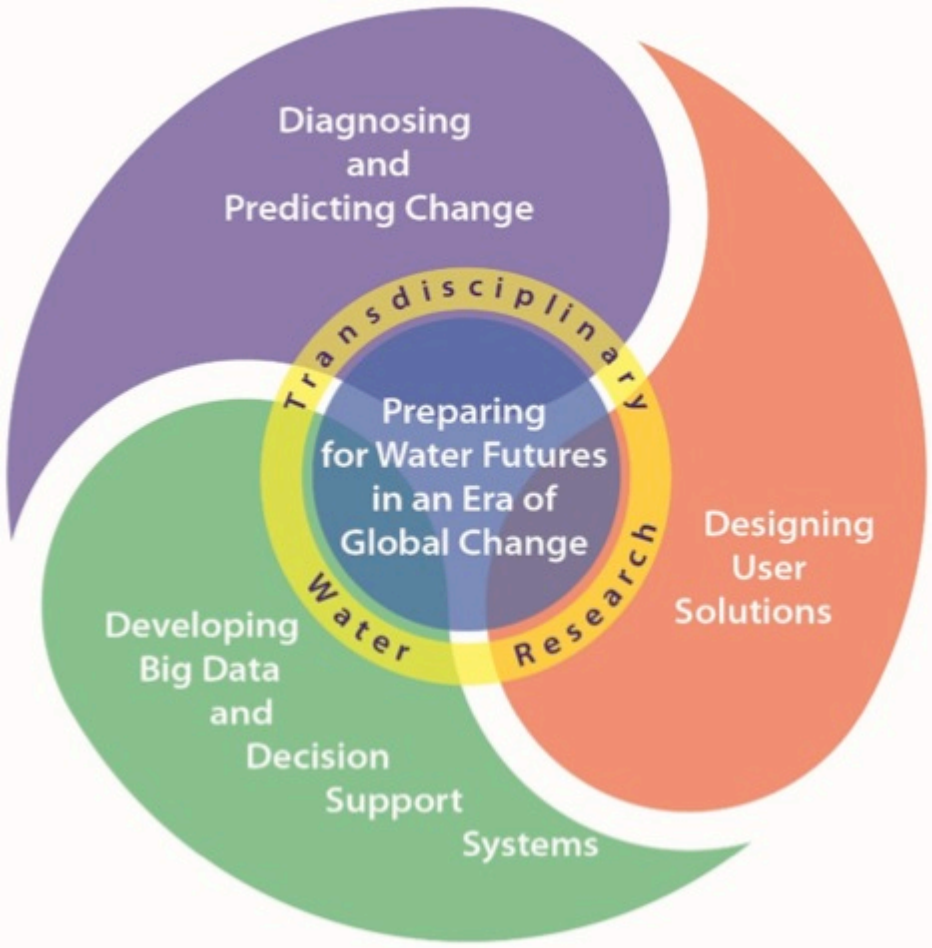
Global Water Futures Mission

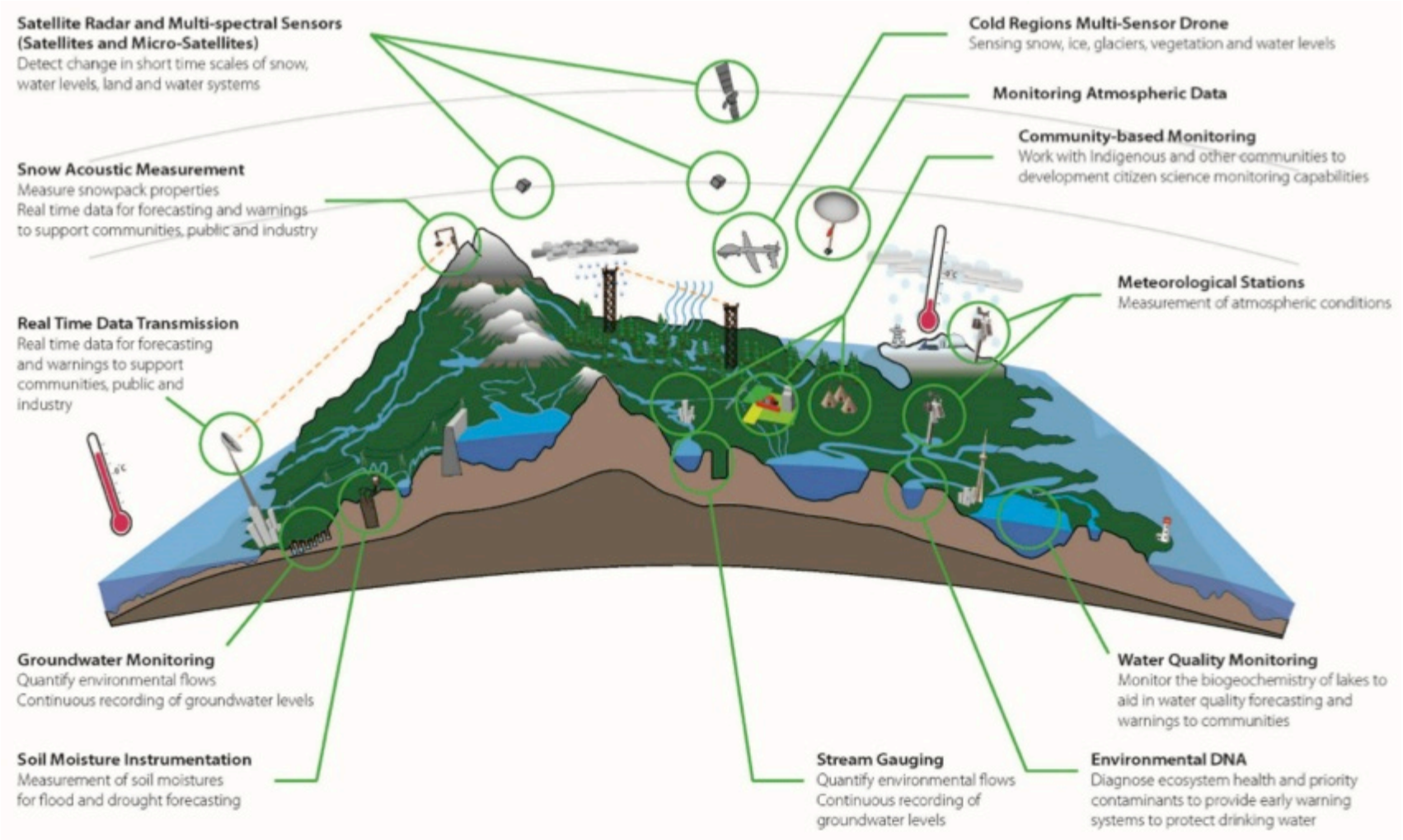
- **Improve disaster warning** – develop scientific knowledge, monitoring and modelling technologies, and national forecasting capacity to predict the risk and severity of extreme events
- **Predict water futures** – use Big Data to make informed decisions, better models to assess change in human/ natural land and water systems
- **Inform adaptation to change and risk management** – propose governance mechanisms, management strategies, and policy tools to reduce the risk of water threats, design adaptive strategies, and enhance economic opportunities

GWF Transdisciplinary Science Pillars

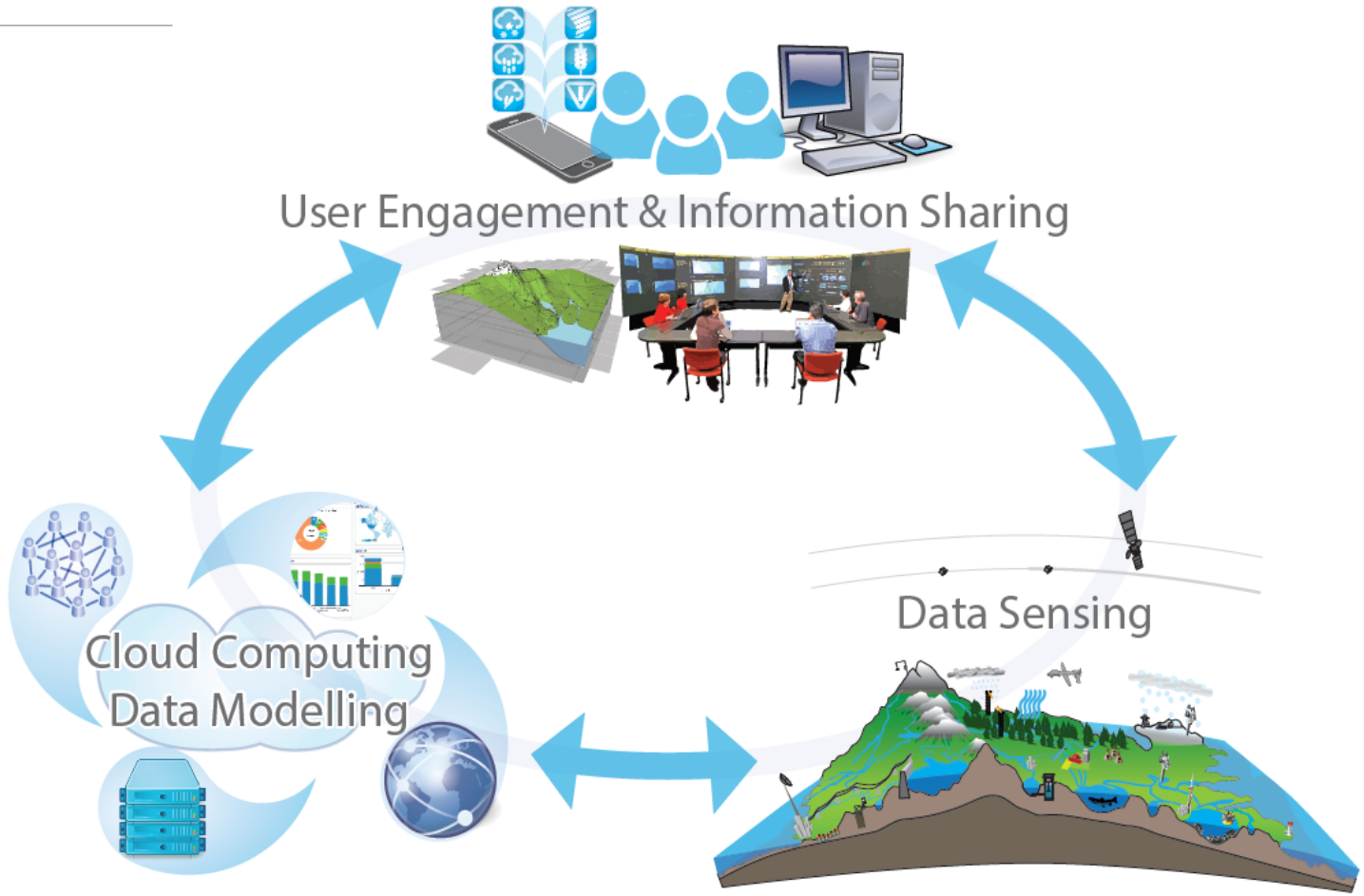
- **Pillar 1** - Diagnosing and Predicting Change in Cold Regions
- **Pillar 2** - Developing Big Data and Decision Support Systems
- **Pillar 3** - Designing User Solutions



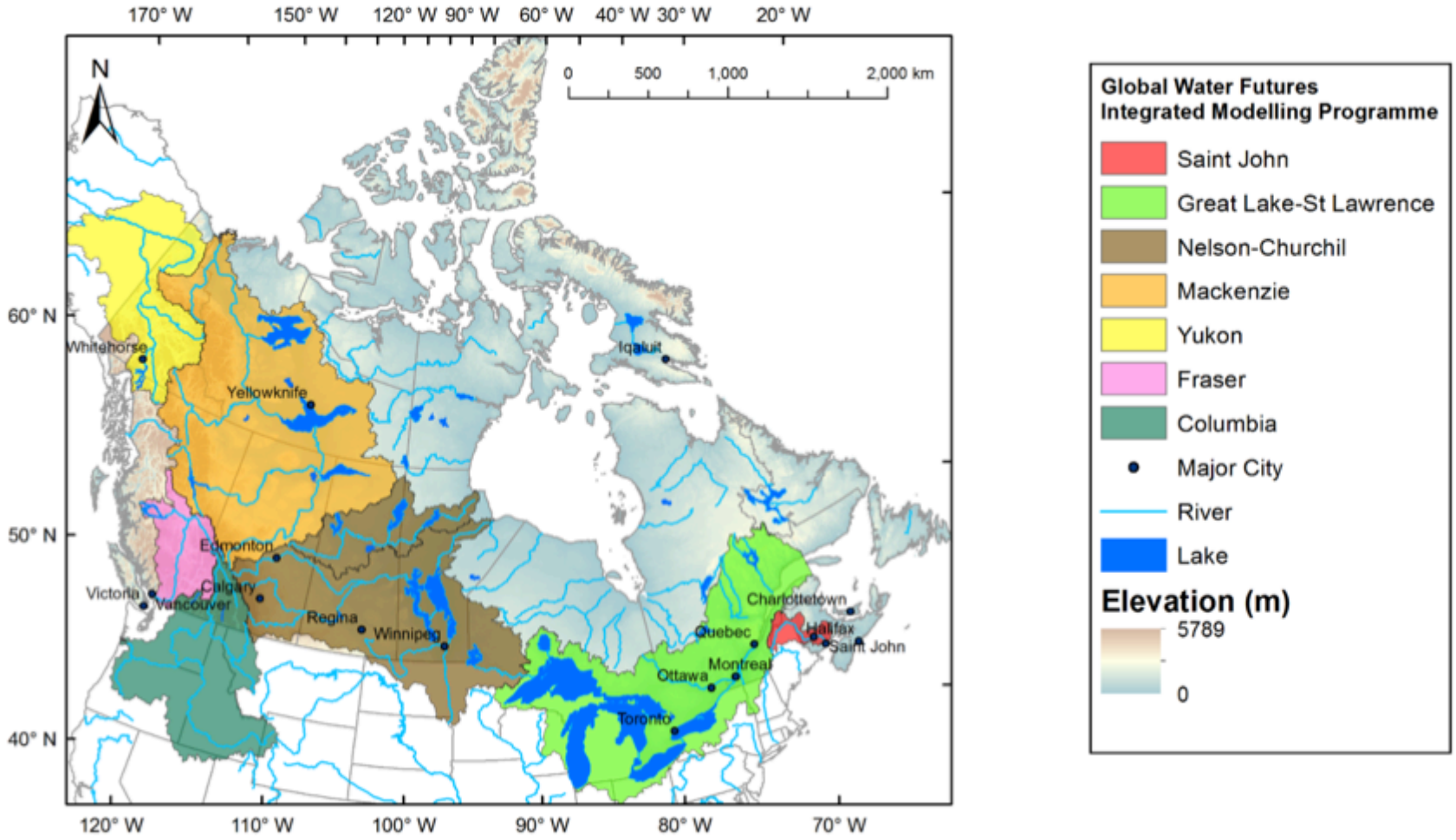
A Revolution in Observing Change



Big Data for Canada's Water



GWF National Modelling Strategy



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National Hydrology Research Centre, Saskatoon

Canadian Centre for Water Forecasting and Prediction, Saskatoon

Coldwater Laboratory, Canmore, Alberta

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