

# The IP3 Research Network: Enhancing Understanding of Water Resources in Canada's Cold Regions



Improved Processes & Parameterisation  
for Prediction in Cold Regions



John Pomeroy & the IP3 Network

[www.usask.ca/ip3](http://www.usask.ca/ip3)



Canadian Foundation for Climate  
and Atmospheric Sciences (CFCAS)

Fondation canadienne pour les sciences  
du climat et de l'atmosphère (FCSCA)

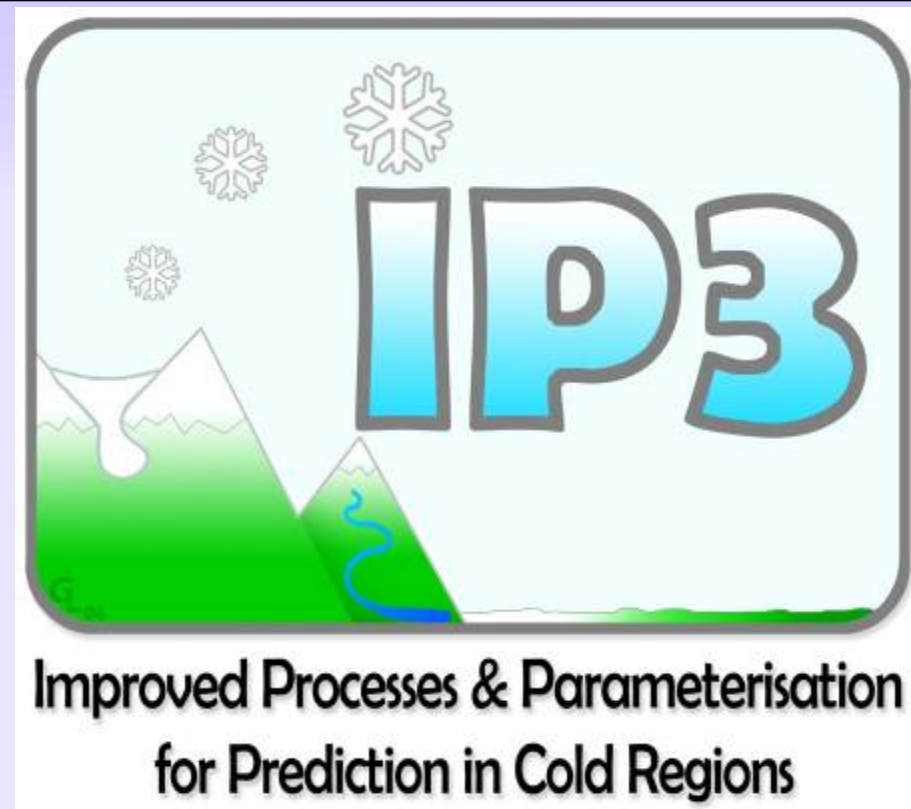
# IP3...

\*...is devoted to understanding **water supply** and **weather systems** in cold Regions at high altitudes and high latitudes (Rockies and western Arctic)

\*...will contribute to better prediction of regional and local **weather, climate, and water resources** in cold regions, including ungauged basin **streamflow**, changes in **snow and water supplies**, and calculation of **freshwater inputs** to the Arctic Ocean

\*...is composed over about 40 investigators and collaborators from Canada, USA, UK, France, Germany, Italy

\*..runs from 2006-2010



# Why IP3?

- \* Need to forecast changing flow regime of streams and rivers in the Western Cordillera and North
- \* Increasing consumptive use of Rocky Mountain water in Prairie Provinces
- \* Uncertainty in design for resource (oil & gas, diamond, etc) development and restoration activities in small to medium size, headwater 'ungauged' basins
- \* Opportunity to improve cold regions snow, ice, frost, soil and water processes in models to reduce predictive uncertainty in:
  - Atmospheric impacts on snow, ice and water resources
  - Simulation of land-cryosphere-atmosphere interaction
  - Cycling and storage of water, snow and ice
  - Prediction of future climate change



# IP3 Network Investigators

**Sean Carey**, Carleton University

Richard Essery, Edinburgh University

Raoul Granger, Environment Canada

Masaki Hayashi, University of Calgary

Rick Janowicz, Yukon Environment

Philip Marsh, University of Saskatchewan

Scott Munro, University of Toronto

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**John Pomeroy (PI)**, University of Saskatchewan

**William Quinton**, Wilfrid Laurier University

Ken Snelgrove, Memorial University of Newfoundland

Ric Soulis, University of Waterloo

Chris Spence, University of Saskatchewan

**Diana Versegny**, Environment Canada

(people in bold are on Scientific Committee)



# IP3 Collaborators

Peter Blanken, University of Colorado

Doug Clark, Centre for Ecology & Hydrology, UK

Bruce Davison, McGill University

Mike Demuth, Natural Resources Canada

Vincent Fortin, MRD - Environment Canada

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Bryan Tolson, University of Waterloo

Adam Winstral, USDA – ARS

James Craig, University of Waterloo

Steve Liang – University of Calgary

# IP3 Secretariat

Housed at Coldwater Centre,  
Biogeoscience Institute, University of  
Calgary, Kananaskis Country;  
Centre for Hydrology, University of  
Saskatchewan, Saskatoon & UNBC,  
Prince George.

- Terrabyte Server for Data and Model
- Archive
- Website, FTP
- CRHM/MESH repository
- Unix Workstation
- High Speed Link to NHRC HAL Computing Cluster



Julie Friddell, Network Manager, Secretary of SC, Secretary of BOD,

Nadine Kappahn (UNBC), IP3/WC<sup>2</sup>N Outreach Coordinator

Michael Allchin, IP3/WC<sup>2</sup>N Information and Data Manager

Edgar Herrera, GEM Modeller

Tom Brown, CRHM Modeller

# IP3 Science Focus

- Snow – redistribution, accumulation, sublimation, radiative transfer and melt
- Forests – effect on radiative and turbulent transfer to snow and frozen ground
- Glaciers - interactions with the atmosphere
- Frozen ground – freezing, thaw, water transmission and storage
- Lakes/Ponds – advection, atmospheric fluxes, heat storage, flow in drainage systems



# IP3 – Goals and Theme Structure

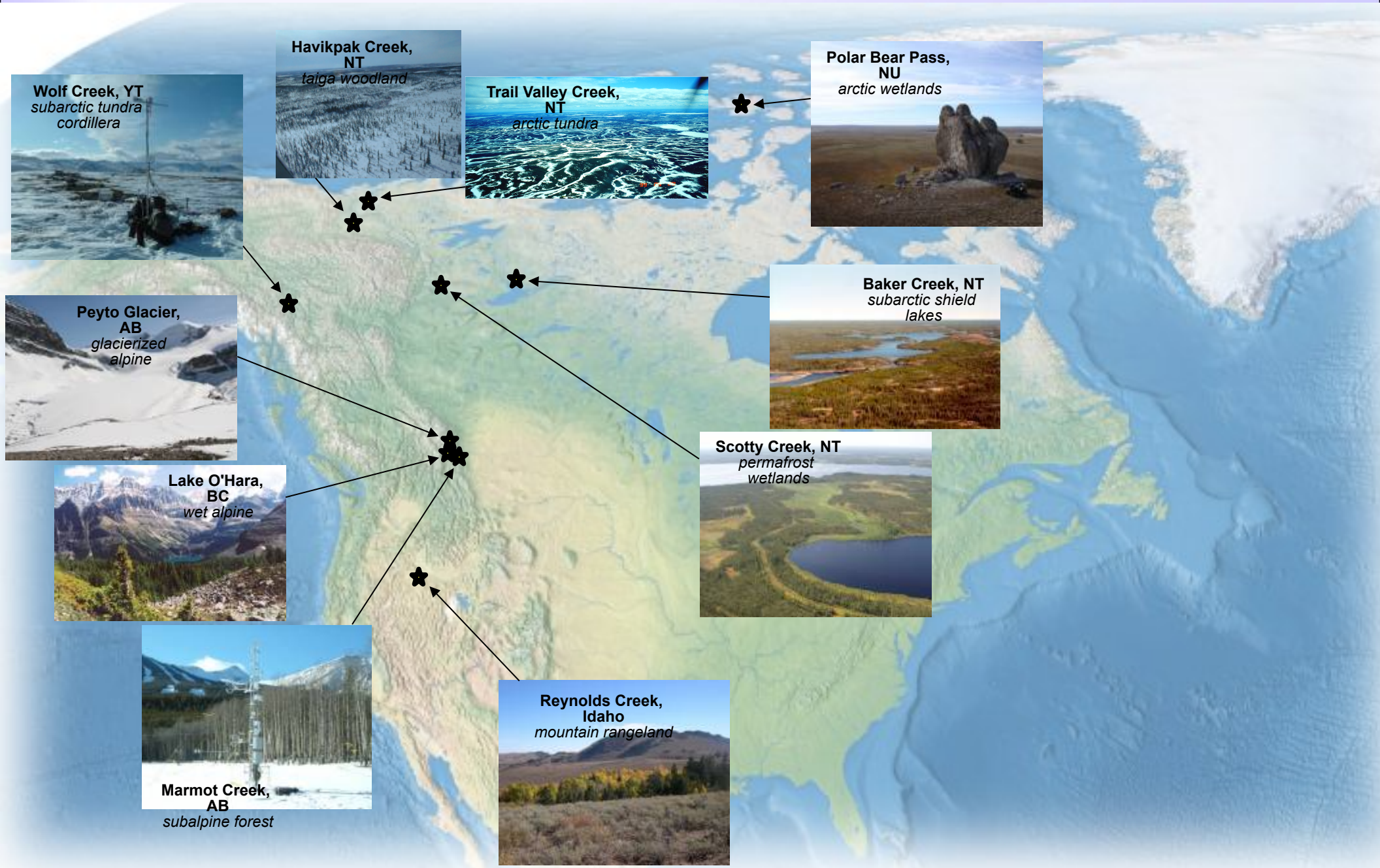
- **Theme 1 Processes: Advance our understanding** of cold regions hydrometeorological processes
- **Theme 2 Parameterisation Develop mathematical parameterisation** of cold regions processes for small to medium scales
- **Theme 3 Prediction Evaluate and demonstrate improved hydrological and atmospheric prediction** at regional and smaller scales in the cold regions of Canada
- *Ultimately* – contribute to **multiscale assessment of coupled climate system, weather and water resources** in cold regions



# Themes to Teams

- Formation of teams to address prediction issues on IP3 basins with suites of models. Mountains, North
- Model testing and evaluation has spanned fine scale fully distributed models with detailed physics descriptions, to moderate scale cold regions models, to larger scale hydrological land surface schemes.
- Learning from failures, consolidating successes
- Models and predictive capability advancing due to synthesis of network experiences

# IP3 Research Basins



# IP3 Final Outputs

- ✧ Improved understanding of cold regions hydrological processes at multiple scales
- ✧ Unique observational archive of research basin data
- ✧ More effective incorporation of cold regions processes and parameterisations into hydrological and meteorological models at regional and smaller scales – CRHM, MESH
- ✧ Improved environmental predictive capability in cold regions in response to greater water resource demands:
  - ❖ Enhanced hydrological and atmospheric model performance at multiple spatial scales *and at scales requested by users*
  - ❖ Improved streamflow prediction in ungauged basins with less calibration of model parameters from gauged flows
  - ❖ Improved weather and climate prediction due to rigorous model development and testing



# New IP3 Initiatives

- Advanced data management system
- Courses on CRHM and MESH given in Ontario, Manitoba, Alberta (Calgary, Edmonton)
- Outreach meetings
- Science monograph

# Network Completion

- HESS Special Issue Cold Regions Hydrology – due date 30 Nov 2009
- Final Scientific Session at CGU/CMOS in Ottawa June 2010
- No cost extension of IP3 to end of Dec 2010
  - ☒ Science Spending to cease by ~June 2010
  - ☒ Special Prediction Effort to cease by Dec 2010
- Secretariat, Outreach and Information Management funded to end of Dec 2010

# IP3 Legacy

- Canada a leader in the understanding of cold regions hydrology (snow, permafrost, ice, rivers)
- Development of network of research basins from Cordillera to Arctic
- Trained cold regions hydrologists and climatologists
- Cold regions hydrological models
- Mechanism for transfer of knowledge to users
- Coupled atmospheric-hydrological prediction models for Government of Canada and other users

# Policy Implications from IP3

- Loss of hydrological “stationarity” due to climate and land use change means traditional risk management analyses are inadequate for water resources management.
- Information for water policy, allocation, conservation and development is required that cannot be provided by analysis of observations alone.
- Improved information can be obtained from the results of coordinated observation and prediction systems that incorporate aspects of data assimilation, enhanced observations, improved model development and continuing process research to deal with evolving unknowns