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

John Pomeroy & the IP3 Network

www.usask.ca/ip3

Canadian Foundation for Climate and Atmospheric Sciences (CFCAS)

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

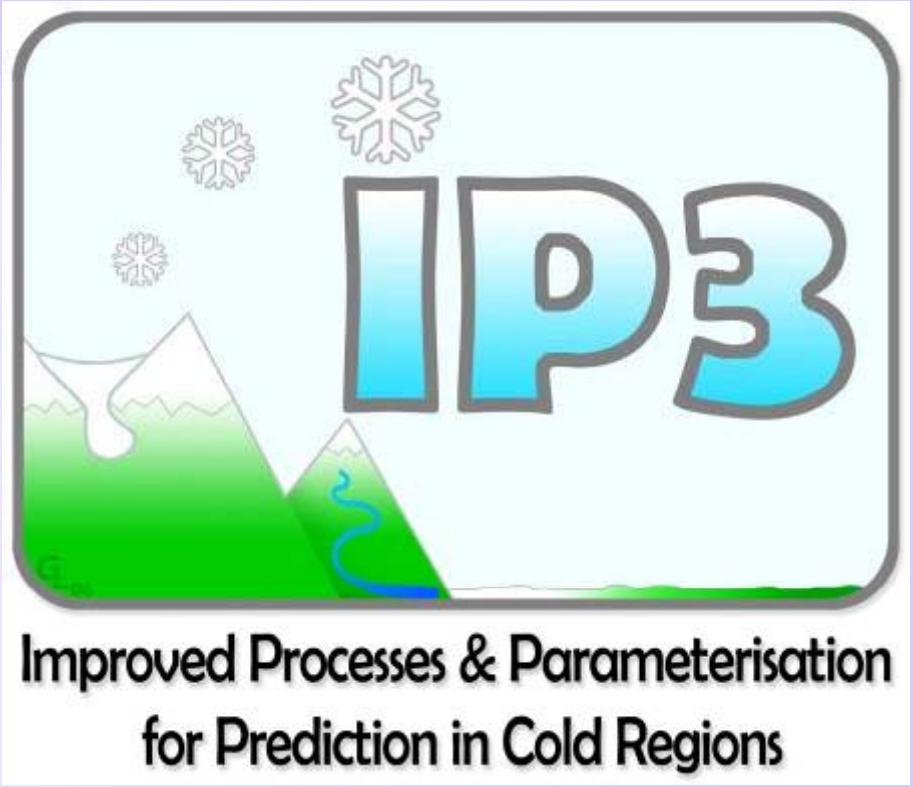
IP3...

- ...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, Germany

- …runs from 2006-2010



Canadian Foundation for Climate and Atmospheric Sciences (CFCAS)

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

IP3 Network Investigators

Sean Carey, Carleton University
Richard Essery, Edinburgh University
Raoul Granger, Environment Canada
Masaki Hayashi, University of Calgary
Rick Janowicz, Yukon Department of Environment
Philip Marsh, University of Saskatchewan
Scott Munro, University of Toronto
Alain Pietroniro, University of Saskatchewan
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 Verseghy, Environment Canada
(people in bold are on Scientific Committee)

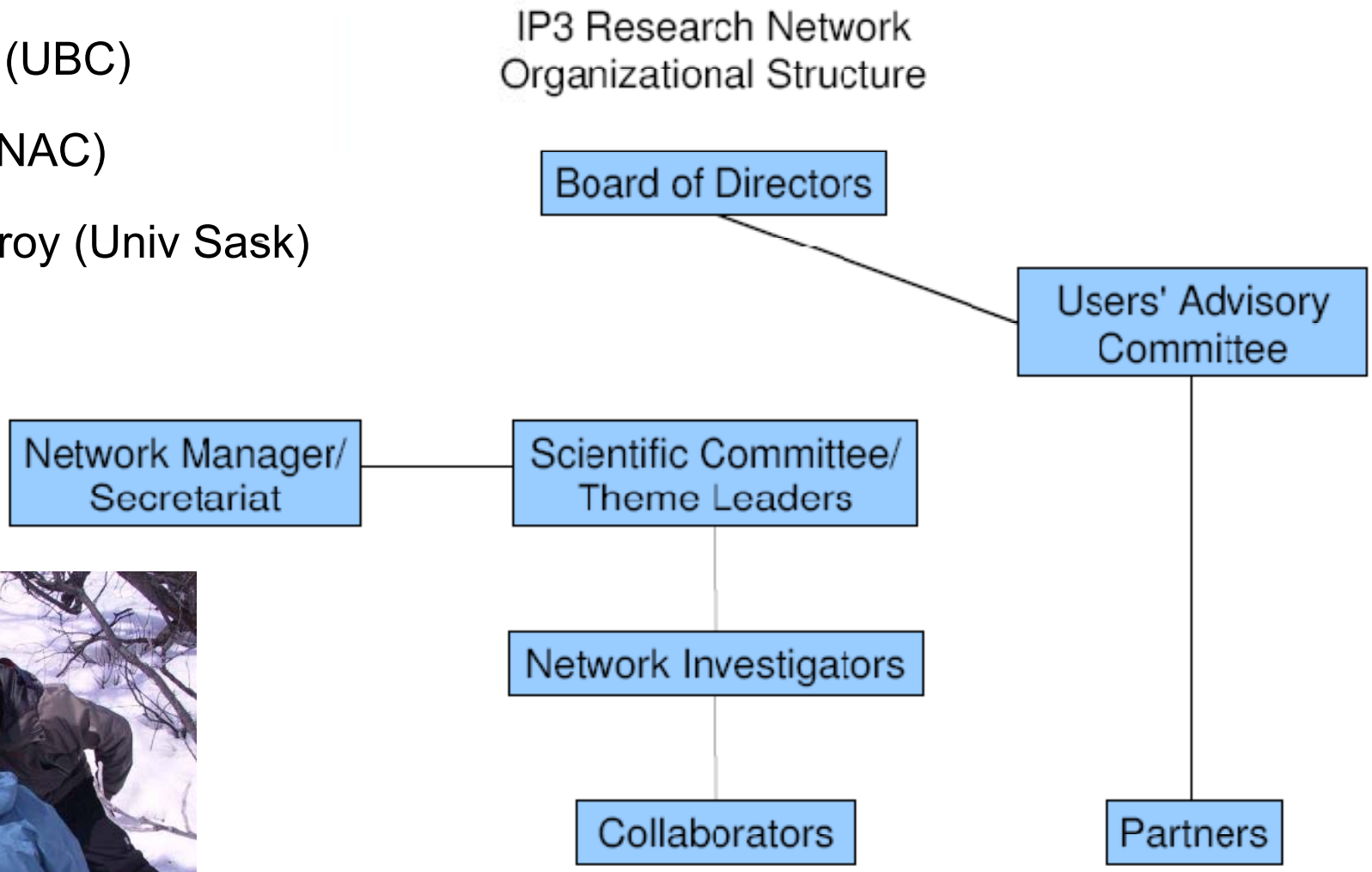
IP3 Collaborators

Peter Blanken, University of Colorado
Tom Brown, University of Saskatchewan
Doug Clark, Centre for Ecology & Hydrology, UK
Bruce Davison, HAL - Environment Canada
Mike Demuth, Natural Resources Canada
Vincent Fortin, MRD - Environment Canada
Ron Goodson, HAL - Environment Canada
Chris Hopkinson, Centre of Geographic Sciences, NS
Tim Link, University of Idaho
Newell Hedstrom, NWRI - Environment Canada
Richard Heck, University of Guelph
Joni Onclin, University of Saskatchewan
Murray Mackay, CRD - Environment Canada
Danny Marks, USDA - Agricultural Research Service
Nick Rutter, University of Sheffield, UK
Frank Seglenieks, University of Waterloo
Mike Solohub, University of Saskatchewan
Brenda Toth, HAL - Environment Canada
Cherie Westbrook, University of Saskatchewan
Bob Reid, Indian and Northern Affairs Canada
Rob Schincariol, Univ. of Western Ontario
Kevin Shook, University of Saskatchewan
Uli Strasser, LMU, Munich, Germany
Bryan Tolson, University of Waterloo
Adam Winstral, USDA - ARS

IP3 Governance

Board of Directors

- Hok Woo (McMaster Univ)*
- Vincent Fortin (Env Canada)
- Dan Moore (UBC)
- Bob Reid (INAC)
- John Pomeroy (Univ Sask)
- CFCAS



IP3 Secretariat

Housed at Centre for Hydrology,
Kirk Hall University of Saskatchewan,
Saskatoon

-Terrabyte Server for Data and Model
-Archive
-Website, FTP
-CRHM repository
-Unix Workstation
-Link to NHRC Hal Lab Cluster

Julie Friddell, Network & Information Manager, Webmaster, Secretary of SC, Secretary of BOD, Secretary of UAC……..

Edgar Herrera, GEM Modeller

Tom Brown, CRHM Modeller

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 at small spatial scales 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 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

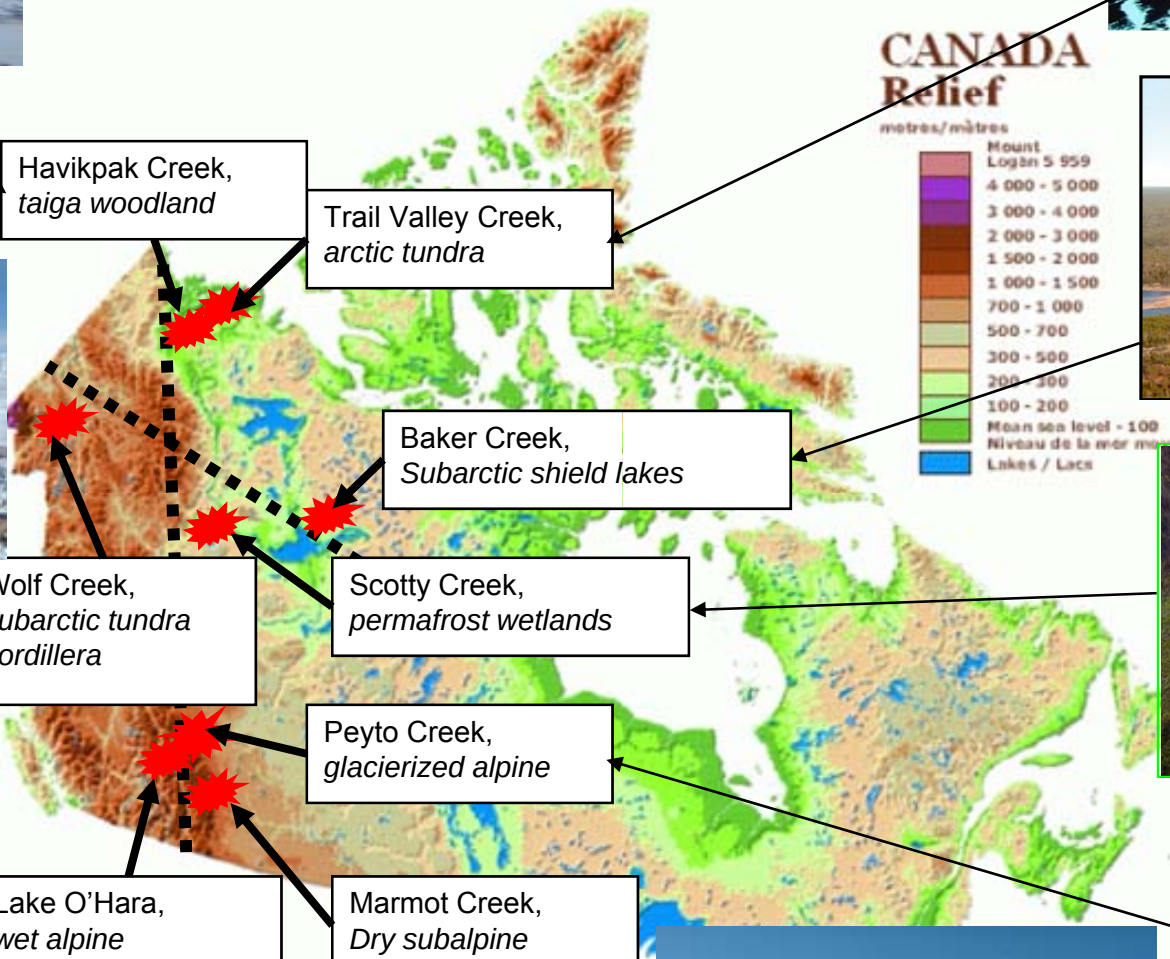
- ***Theme 1 Processes:*** **Advance our understanding** of cold regions hydrometeorological processes
- ***Theme 2 Parameterisation*** **Develop mathematical parameterisation** of cold regions processes for small to medium scales
- ***Theme 3 Prediction*** Evaluate and demonstrate **improved hydrological 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

Processes

→ Multi-scale observations of effect of radiation, wind, vegetation, and topography on the interaction between snow, water, soil, and air

IP3

Research Basins



Havikpak Creek,
taiga woodland

Trail Valley Creek,
arctic tundra

Baker Creek,
Subarctic shield lakes

Wolf Creek,
subarctic tundra cordillera

Scotty Creek,
permafrost wetlands

Peyto Creek,
glacierized alpine

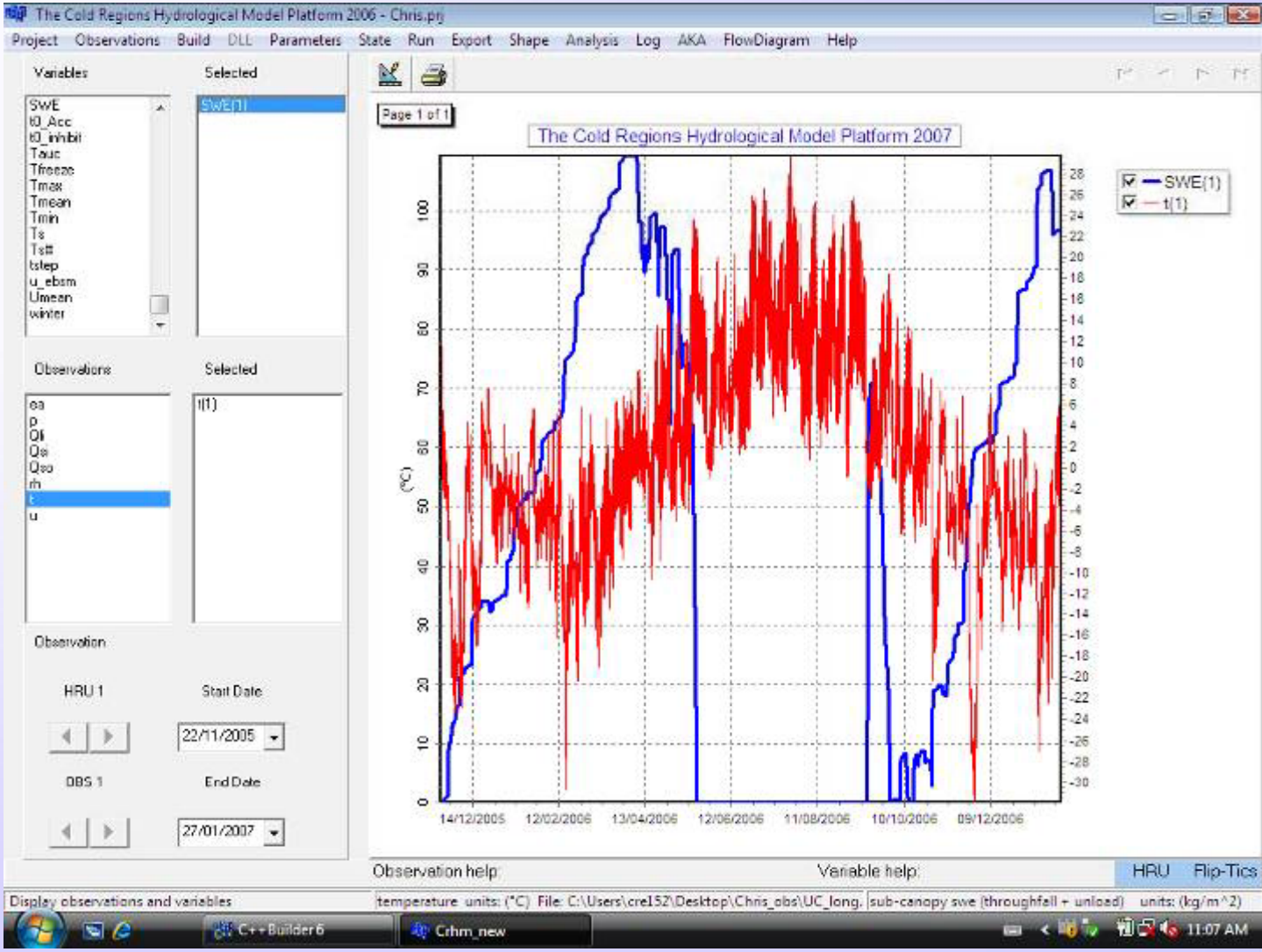
Lake O'Hara,
wet alpine

Marmot Creek,
Dry subalpine

Parameterisation

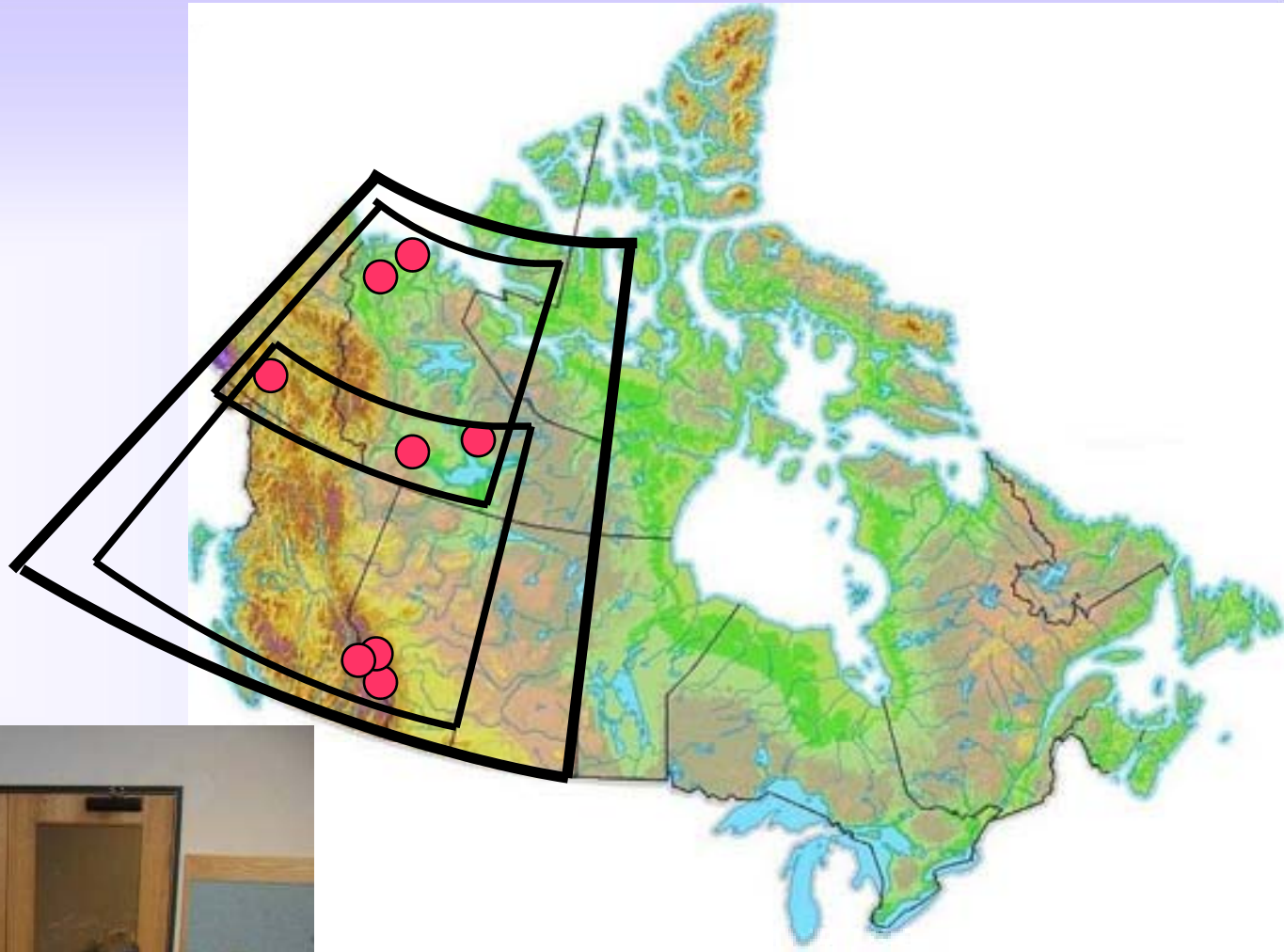
→ Scaling of hydrological processes

→ Minimize model complexity while reproducing the essential behaviour of the system



Cold Regions Hydrological Model CRHM

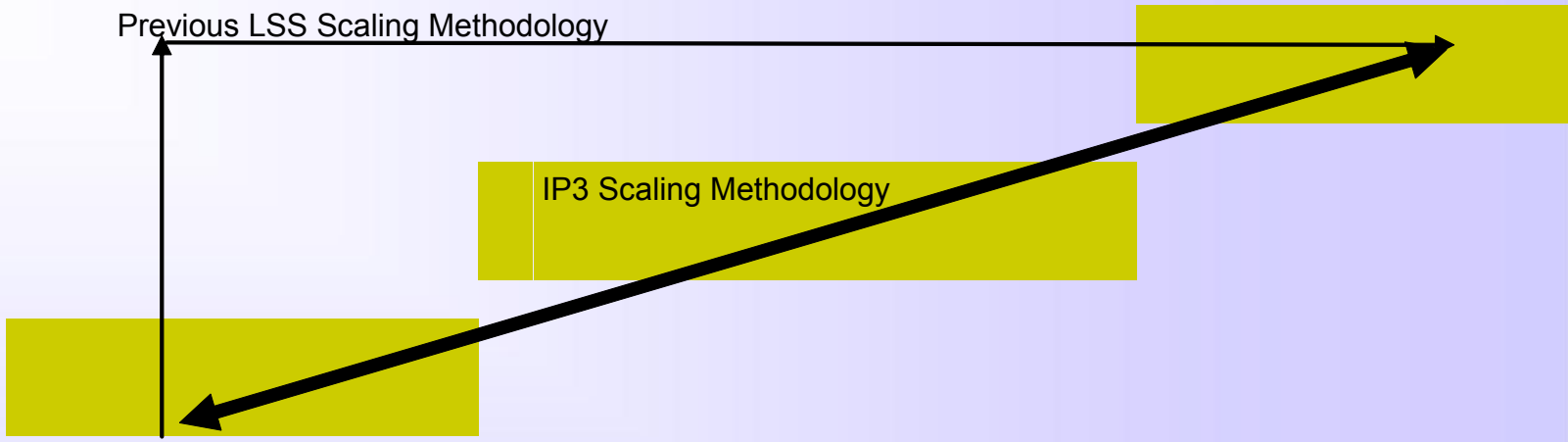
Prediction



→ Water resources (storage, discharge, snow cover, soil moisture), atmosphere-ground interaction (evaporation), and weather and climate

IP3 Scaling Methodology

	Resolution	1 m	100 m Landscape type	100 m - 2 km Pattern/tile	2 - 10 km	10 km -	10 km
		Tile/HRU Point	Tile/HRU Hillslope	Grid/small basin Sub-basin	Multi-grid/medium basin Basin	Multi-grid Mesoscale	Regional;
Prediction	Terrestrial Open Water Snow and Ice						
Parametrization	Terrestrial Open Water Snow and Ice						
Process	Terrestrial Open Water Snow and Ice						
MODELS		CHRM	CHRM	MESH CHRM CEOP Hydrology	MESH CHRM CEOP Hydrology	MESH	MESH

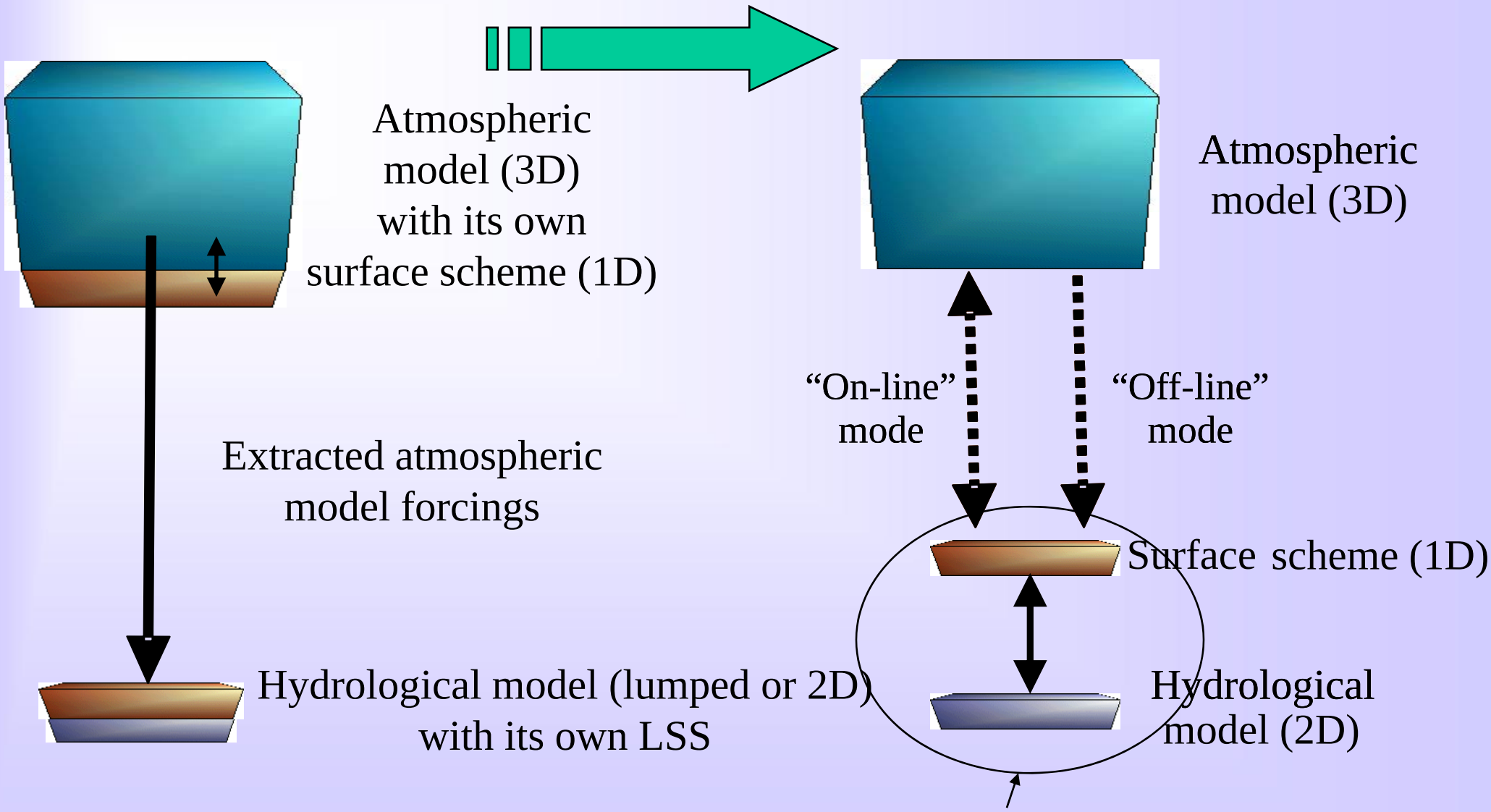


Quinton CFCAS Study---------->

<----------MAGS

Integrating the TOP DOWN and BOTTOM UP approaches

Modélisation Environnementale Communautaire, MEC



MESH – MEC - Surface and Hydrology

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
- 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

Users' Advisory Committee

- Public and private: community, government, industry,…
- Goal is to provide information that can be used in regional planning/policy making, streamflow/flood forecasting, weather/climate forecasting, water management, environmental conservation, and northern development
- Interactive workshops for outreach to practitioners and feedback on applicability of research

Recent Activities

- Field work began in spring
  - Several processes better understood
- Parameterisation of several processes underway with good progress
- Model development:
  - CLASS 3.3 finalized
  - CRHM – initialized for most basins, forest parameterisations added
  - MEC/MESH – initialized for several basins, training workshop
- GEM Modeller, several students and postdocs started summer 2007
- LiDAR surveys of all 8 basins completed August 2007
- IPY Arctic Freshwater Systems: Hydrology & Ecology Network started

IP3 in the World

- PUB - IP3 hosts Working Group #16 of the IAHS Decade for Prediction in Ungauged Basins
- GEWEX GLASS – cold regions contribution to land surface scheme component of the Global Energy and Water Cycling Experiment of the World Climate Research Programme
- CliC – Climate and Cryosphere Project – application being made to affiliate with Theme 1
- Significant collaborations supported by USDA, NERC
  - North American Cordilleran Transect
  - Comparisons with European Arctic cold regions hydrometeorology

IP3 in IPY

- "**Arctic Hydra**", the Arctic Hydrological Cycle Monitoring, Modelling and Assessment Program' international network
- **Arctic Freshwater Systems: Hydrology and Ecology** (***Wrona and Pietroniro***) Canadian network
- **Theme 1, Freshwater Flux and Prediction of Arctic Freshwater Systems Network** ***(Pomeroy and Pietroniro)***
  - Quantification of key hydrological/cold regions processes/parameters affecting freshwater flux to the Arctic Ocean
  - Validation and improved coupling of hydrological/land surface models to predict freshwater flow/flux to the Arctic Ocean
  - Improved assessment of the hydro-climatology of the Canadian Arctic

Arctic Freshwater Systems, Theme 1 Funded Investigators

- Barrie Bonsal
- Sean Carey
- Bruce Davison
- Stephen Dery
- Raoul Granger
- Masaki Hayashi
- Rick Janowicz
- Phil Marsh
- Al Pietroniro
- John Pomeroy
- Terry Prowse
- Bill Quinton
- Dale Ross
- Ric Soulis
- Chris Spence
- Kathy Young

Upcoming Meetings

- Planned Meetings :
  - Themes 2 and 3 Workshop (Parameterisation/Prediction)
  - CRHM training Workshop (possibly January)
  - Users' Advisory Workshop
  - Session at Canadian Geophysical Union with WC2N in May – Banff, Alberta

Thank you!

Please visit us at
www.usask.ca/ip3

Thank you to IP3 participants for providing photos!