

Water Resources and the Cryosphere in Mountain and Northern Canada An IP3 Users/Stakeholders Community Workshop report

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A workshop on cold regions hydrology and cryospheric science research by the IP3¹ Research Network was held 12-15 November 2008 in Whitehorse, Yukon, Canada. The IP3 Network includes researchers from across Canada, Europe, and the United States. Workshop participants included IP3 investigators and collaborators, various members of the user community such as watershed managers, development planners, hydrological forecasters and ecosystem specialists, and collaborating partners from related national and international programs such as the *Western Canadian Cryospheric Network*, *Drought Research Initiative*, and representatives from the *International Polar Year* initiatives.

Scientific reports were presented by investigators detailing their 2008 research activities. A poster session gave graduate students the opportunity to display their contribution to current research, while a well attended public presentation on “Water in the Changing North” by Dr. Sean Carey of Carleton University in Ottawa gave many interested local observers a chance to ask questions of scientists and share concerns on water issues in the north. An important part of the workshop involved user’s perspectives on IP3 research and included presentations on watershed management, fish habitat, permafrost-related landslide issues and adapting water management practices to incorporate new research findings.

With recent reports of greater snowfall, melting glaciers, and thawing permafrost, Canada’s changing mountain and northern cold regions are presenting challenges for management of the nation’s water supply, infrastructure, and ecosystem health. IP3 research is currently focused on obtaining a better understanding of cold region processes, parameterising these processes and testing and validating these new parameterisations in cold regions models.

Research presented at the workshop included:

- * Process and initial parameterisation studies on northern landscapes with lakes, open wetlands and peat plateaus. Topography has been demonstrated to have strong control on frost table position, with frost table position affecting hydrological connectivity through fill and spill mechanisms on small spatial scales. A new open wetland development sequence as a result of permafrost thaw was presented – as canopy coverage

decreases due to permafrost thaw, increased incoming shortwave radiation to the ground surface causes a depression in the frost table which eventually disappears creating an open wetland. Basin runoff in the context of changing ground cover was examined - shrinking peat plateaus and increasing wetlands lead to decreased runoff to streams (Quinton).

- * Studies of snow dynamics including wind modeling over complex terrain. A blowing snow parameterisation for large-scale models and land surface schemes is being developed, whereby snow will be transported between landscape units and between grid squares. Blowing snow modelling results demonstrate that explicit representations of both topography and vegetation must be included. Turbulent transfer and wind flow direction is crucial for many cold regions processes to characterize the relationship between topography and windflow (Pomeroy).
- * Validation of snow process parameterisations in alpine, arctic and forested environments has led to the development of innovative snow observation techniques. An acoustic device that can determine snowpack depth and density has been developed and tested. This device is inexpensive and less time consuming as compared to traditional snow surveys. Further development of this device will include determining snowpack tortuosity (Pomeroy).



Photograph of the acoustic snow water equivalent gauge being deployed to send and receive a sound wave through the snowpack. The device has on board signal processing to estimate depth and density from the transformation of a frequency-swept sound wave returning from the snowpack.

¹ Improved Processes & Parameterisation for Prediction in Cold Regions. The IP3 Research Network is headquartered at the University of Saskatchewan Centre for Hydrology.



A photograph of the meteorological station and time lapse camera at Marmot Creek Research Basin in the Canadian Rockies. The station is used to provide hydrometeorological data to run and validate blowing snow, snowmelt and snow covered area depletion models.

- * Development of parameterisation for energy balance snowmelt modelling associated with various shrub exposures has demonstrated the importance of modelling vegetation characteristics. Use of new LiDAR datasets gives improved topography and vegetation height data compared to standard DEM and Landsat classifications, for high-resolution modelling (Essery).
- * Snow and small lake processes – roles of lake size, depth and shape on evaporation were presented. The product of horizontal wind speed and the difference between water surface and atmospheric vapour pressure were shown to have strong control on lake evaporation. Further work is to be done through testing lake evaporation parameterisations with the objective of improving understanding of radiation and turbulent fluxes at a range of scales (Marsh).
- * Glacier process studies have shown that most glacial melt delivery to lakes occurs underground with sustained baseflow suggesting that groundwater is storing melt (snowmelt, glacial melt, rain) and slowly releasing it. Use of ground penetrating radar and electrical resistivity imaging has been used to respond to issues with debris covered glaciers (Hayashi).
- * Use of LiDAR data is invaluable in identifying areas with a process focus – identifying contributing area dynamics leading to where streamflow will occur allows better modeling of storage distribution and importance of connectivity (Spence).
- * CLASS (Canadian Land Surface Classification Scheme) was originally developed for the CGCM and treats fluxes of energy and water at the land surface. Enhancements in the release of the latest version (3.4) include new formulations for snow density, interception, sublimation, thermal structure, liquid water, and

ability to model organic soils, improved vegetation turbulent fluxes and soil evaporation, revised soil thermal conductivity calculations and an option for multiple soil layers at depth (Verseghy).

Plans were made for 2009 research which includes teams working together on the following parameterisation issues:

- * Snow: redistribution, accumulation, sublimation, radiative transfer, melt and areal depletion
- * Vegetation: effect on radiative and turbulent transfer to snow and frozen ground
- * Glaciers: interactions with the atmosphere
- * Frozen ground: freezing, thaw, water transmission and storage
- * Hillslopes: water redistribution, runoff generation
- * Lakes, ponds, wetlands: runoff, advection, atmospheric fluxes, heat storage, storage and flow in drainage systems

The workshop ended with much discussion on the importance of continuing the current research with follow-on activities. Key conclusions included the importance of atmospheric and hydrological scientists working together, deepening relationships with other networks (CliC, GEWEX, GEO), and the development of strategic networks involving the larger community in developing a nationwide team of scientists to tackle the issues in advancing our understanding and predictive abilities in cold regions water resources research.

Detailed workshop results are available at:
<<http://www.usask.ca/ip3/>>.

Note: The IP3/CliC affiliation was formally endorsed by the CliC SSG-IV (Nov 2007). - CIPO