

NEWSLETTER

Improved Processes and Parameterisation for Prediction in Cold Regions



DECEMBER 2009

Workshop Report

IP3-WC²N Joint Workshop in Lake Louise

IP3 and WC²N (Western Canadian Cryospheric Network) held a very successful joint workshop in Lake Louise, Alberta from 14 to 17 October, 2009. This marked the first time that two Canadian Foundation for Climate and Atmospheric Sciences (CFCAS) networks held a joint workshop. Bill Fisher, Director General of the national parks in western and northern Canada, officially welcomed workshop participants and stressed the importance of researchers and Parks Canada working together to share monitoring and research information with both each other and the public. Erica Wilson, speaking for CFCAS, stressed the importance of user groups as well in sharing outcomes of network research. Brian Menounos, principal investigator for WC²N, gave an overview of the network's accomplishments in documenting climate variability and changes in glacier extent in British Columbia and Alberta over the past 400 years; detailing the links between meteorological processes and glacier mass balance. Researchers are now using this information to project how glaciers will respond to future climate

change scenarios. John Pomeroy, principal investigator for IP3, highlighted the concept that hydrological processes in Canada's cold regions are out of established equilibrium and that natural variability in snowfall, river flow, lake levels and permafrost is changing. Future planning for water use and availability will require coordinated observation and prediction systems to provide the necessary information for water policy, allocation and conservation. A busy two and a half days saw fifty different presentations from both networks and guests. A poster session was held on the Friday evening and over twenty five posters lined the walls of the Lake Louise Inn ballroom. Grad students, IP3 and WC²N researchers and guests were pleased to have the opportunity to share their enthusiasm in presenting their work.



Outreach Announcement

The IP3 community Forum was officially launched on December 14th, to allow all interested parties to participate in a discussion forum on the IP3 website. The Forum can be accessed from <http://arts-hydrology-ip3.usask.ca/forum> as well as directly from the IP3 website, under the Users area. There are currently three forums on the site - a CRHM forum—offering a means to interact with individuals who have attended one of the CRHM courses as well as the CRHM developer regarding applications and changes to the model; a MESH forum for discussion on model usage and improvement, and an IP3 general forum. When posting to the Forum, please use clear tags for your posts, such as “Support Request” or “Enhancement Suggestion”, along with any information on your use of the model, including which version and your individual requirements. The Forum will be moderated on a weekly basis by CRHM and MESH developers and IP3 personnel.

Lake Louise Workshop Session Summaries

Modelling

The modelling session featured reports on the various models being utilized under the IP3 banner including the Modélisation Environnementale Communautaire Surface and Hydrology Model (MESH), Canadian Land Surface Scheme (CLASS), Cold Regions Hydrological Model (CRHM) and Global Environmental Multiscale Model (GEM). Specific topics included:

- * parameterisation of soil water in modelling processes in CRHM
- * discussion of parameterisations for landscape topography and vegetation, snow accumulation regimes, blowing snow transport, snow energetics, snow interception and run-off generations included in MESH
- * model performance comparisons of simulated streamflow discharges at Wolf Creek and Marmot Creek
- * calibration of the MESH model as applied to Reynolds Creek through improvements to soil budget components of the MESH model
- * study of snow transport over Marmot Creek combining outputs from GEM and MEC for use with CRHM in understanding relationships between climate, snow pack, and snow cover

Modelling—invited presentation

Olga Semenova, a Russian hydrologist from the State Hydrological Institute in St. Petersburg, was invited to the workshop to present on Russian efforts in creating a universal hydrographic model. Evolving Russian hydrographic models harmonize simulations and streamflow in such disparate locations as Costa Rica and Angola for both streamflow and soil moisture. The physical scale of the research basins in Russia were highlighted and the size of basins in Russia were compared to Canada where the South Saskatchewan basin would be considered a medium to small size basin by Russian standards! Dr. Semenova's presentation highlighted weaknesses in several conventional algorithms used in North American models and raised questions on the appropriateness of parameterisations used in current models. Dr. Semenova stressed the importance of not just using a single model or established approaches only and suggested the key to accurate predictive modelling lies in the use of multiple model testing over basins varying in both scale and topography.



IP3 is offering a training session on the Cold Regions Hydrological Model (CRHM), in Red Deer, Alberta, on Tuesday, 12 January, 2010. Participants will also have an opportunity to attend an informal Q & A technical session on the morning of January 13th. A water management workshop will follow for those interested in feature scenarios and application potential in using CRHM for water management. Registration or questions can be emailed to ip3.network@usask.ca

Mini Workshop on Data Archiving

Michael Allchin, IP3 and WC²N Data Information Manager, hosted a session on the importance of data archiving. After a generic introduction to the process of selecting a data archival system and the bare bones of developing a system, Steve Liang gave a presentation on GEOspatial Cyberinfrastructure for Environmental Sensing (GeoCENS) highlighting the importance of mass collaboration. The importance of sensor networks and their integration with the sensor web highlighted missing links between the two. The GeoCENS mission statement was introduced—to enable scientists to share and access scientific data and collaborate on a scale and process not currently possible. Goals of the institute include the ability for scientists to access biogeological sensors and data sets, publish new sensor/data sets and use Canada's Advanced Research and Innovation Network (CANARIE) to access, transfer and share data sets, allowing more effective collaboration with colleagues around the world.

Northern Basins

The session on northern basins highlighted IP3 and IPY research in northern Canada and included presentations on:

- * the importance of studying the tundra-forest transition zone as shrubs expand further into tundra areas under climate change, and the importance of shrub cover in parameterising snowcover, snowmelt and radiation regimes for modelling and parameterization schemes
- * the shifting boundaries in permafrost thaw is causing changes in basin runoff, in response to this permafrost melt, the challenge is to develop a conceptual model of permafrost melt to show the sequence of events as thaw occurs by coupling hydrological and permafrost models to predict future scenarios
- * the importance of connectivity in stream networks, particularly the disconnect that occurs later in the summer is important for modelling network processes
- * climate change in the Yukon is causing extreme hydrological impacts including increased winter low flows due to greater ground water contributions resulting from changes in the permafrost regimes while increasing peak flows are occurring due to increased glacial melt



Mountain Basins

The mountain basin session covered the entire IP3 mandate with presentations on process, parameterization and prediction. Selected presentations focused on:

- * parameterisations of vegetation for snowmelt modeling
- * hydrological storage and pathways in alpine headwaters
- * boundary layer flow models for glacier flux estimates
- * the importance of blowing snow in studying glacier mass balance with suggestions for either dense monitoring networks or high resolution modelling for quantification purposes
- * snow dynamics and modelling in open and forested basins including turbulent transfer over snow, blowing snow parameterisations, snowmelt modeling, and forest snow interception, sublimation and unloading



Glaciers

Glacier sessions highlighted ongoing work by WC²N team members with presentations from both research scientists and their grad students. Highlights included:

- * historical glacier extents and elevations through development of a Landsat-based inventory of glaciers in western Canada
- * glacier change in the Canadian Rocky Mountains
- * Alberta glacier outlook—modelling mass balance and synoptic patterns
- * modelling of future glacier melt using radiation, precipitation and temperature regimes
- * simulated glacier mass balance and radiation modelling for regional glacier melt

IP3 is looking at the possibility of offering a training session on the Cold Regions Hydrological Model (CRHM), in Yellowknife, Northwest Territories, in May, 2010, pending interest of a sufficient number of participants. Registration or questions can be emailed to ip3.network@usask.ca

For more detailed information, pdf files for presentations and posters from the Lake Louise workshop can be accessed directly from the IP3 website at http://www.usask.ca/ip3/ws4_presentations.html

Climate Sensitivity of Alpine Snow Regimes in the Canadian Rockies

John Pomeroy was invited to present “Climate sensitivity of alpine snow regimes in the Canadian Rockies” (J. Pomeroy, A. Sabourin, M. MacDonald) for the Canadian Water Resources Association/Canadian Society of Hydrologic Sciences (CWRA/CSHS) discussion meeting hosted by the Pacific Climate Impacts Consortium on December 8, 2009. The presentation discussed the research being done in the Marmot Creek research basin and led into a brief discussion of the development of the Cold Regions Hydrological Model (CRHM) and the further development of snowmelt modelling. Specific climate change impacts on blowing snow fluxes, maximum snow accumulation, snowmelt rate and snowpack duration and depletion rates was also presented. A panel discussion with Allan Chapman from the B.C. River Forecast Centre, Markus Schnorbus from the Pacific Climate Impact Consortium, and Shawn Marshall from the University of Calgary, debated the major challenges in modelling snowmelt processes and the need for more spatially explicit snowmelt products for mountainous regions. The presentation was broadcast live online and attracted many interested viewers.



IP3 science will be represented at the upcoming European Geosciences Union (EGU) General Assembly in Vienna in May 2010, with Dr. John Pomeroy as an invited speaker for the session Mountain Hydrology : Observations, processes and models (HS4.13). Abstract submission and more information can be found at <http://meetingorganizer.copernicus.org/EGU2010/session/1998>



Course Offering

Physical Principles of Hydrology

The Canadian Society of Hydrological Sciences, in partnership with the University of Saskatchewan, is offering a short course entitled “The Physical Principles of Hydrology” to be held at the University of Calgary’s Biogeoscience Institute’s Barrier Lake Station in the Kananaskis Valley from March 2-11, 2010. This course is directed to graduate students and early to mid-level career water resource engineers, hydrologists, aquatic ecologists and technologists who are either working directly in the disciplines presented or are looking to broaden their understanding of hydrological systems and processes. Factors governing hydrological processes in Canadian landscapes will be discussed including precipitation, interception, snow accumulation, snowmelt, evaporation, infiltration, groundwater movement and streamflow. Details and registration are available at http://www.cwra.org/branches/cshs/Principles_of_Hydrology_Workshop.aspx. Enrollment is limited to 40 students, so please register early! For further information, please contact Dr. Christopher Spence at chris.spence@ec.gc.ca or Dr. John Pomeroy at john.pomeroy@usask.ca.

The Cold Regions Hydrology Users Group (CRHUG) is creating a questionnaire to be distributed to all members of the cold regions hydrological community for input on information the community requires for their use beyond the current funding end dates of Dec 2010 for both IP3 and WC²N networks. For input to this process or more information please email Nadine Kapphahn at nadine.kapphahn@usask.ca

Students in the News



Fall 2009 has been a newsworthy season with several IP3 students from the University of Saskatchewan having their work featured in various public venues and media. Ross Phillips gave a public lecture in Yellowknife in September, 2009 on Baker Creek hydrology which was recorded by CKLB, a Yellowknife radio station. Ross conveyed to the audience an understanding of watersheds, runoff contributing areas,

**THE 5 W's OF STREAMFLOW
IN BAKER CREEK**

**A PUBLIC LECTURE FOLLOWED BY OPEN
DISCUSSION ON NEW WATER RESEARCH AND
MONITORING CONCEPTS CURRENTLY TAKING
PLACE IN THE WATERSHED FEEDING BAKER CREEK**

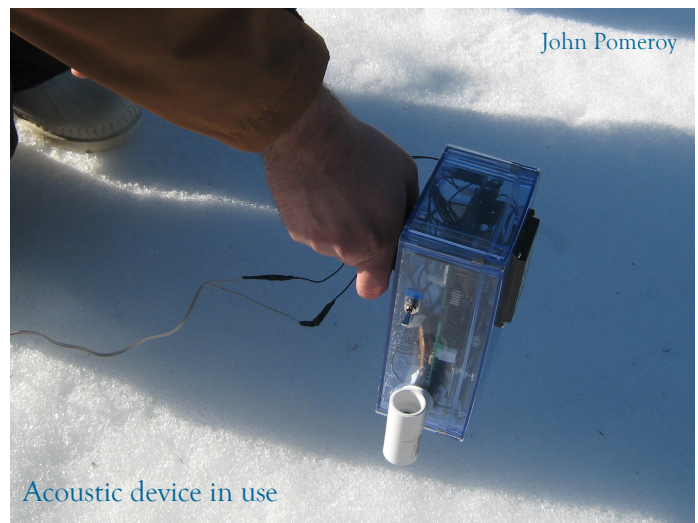
*Date: September 29, 2009
Time: 7:30 – 8:15 pm
Location: Prince of Wales Northern
Heritage Centre (Museum) Auditorium*

*Ross Phillips, a M.Sc. student from the
University of Saskatchewan, is part of a
team working to better understand taiga
shield streams. He will be presenting the
content of his research, and talk about
what the results of his project mean for
local water managers and the community
in general.*



streamflow connectivity and how they relate to flow in Baker Creek, a research site including a series of interconnected lakes draining a watershed north of Great Slave Lake. Field work from 2008 and 2009 was presented demonstrating flow connectivity on maps generated from satellite images and on site hydro-meteorological measurements. Ross's presentation highlighted the changing stream network noting the relevance of this type of research to the management of mine sites, flow forecasting for hydro-power, and the design of water related structures.

Nicholas Kinar (whose work was featured in the June IP3 newsletter) was interviewed on CBC radio's Saskatchewan Morning Edition in November as well as having an article published in the Saskatoon Star-Phoenix. Nicholas enthusiastically shared his passion for his research live on air with Sheila Coles, outlining the importance of accurate snow water equivalent measurements in snowpacks. His work on the



Acoustic device in use

design, manufacture and implementation of a device for measuring the water content of snow through the use of sound waves offers many potential uses for the collection of snow properties measurements such as temperature and density as the snowpack evolves, allowing for more reliable water and snowmelt predictions.

Stacey Dumanski, was also published in the Saskatoon Star-Phoenix in October, 2009 for her work with Parks Canada at Sheep Creek in Ivvavik National Park, Yukon. This project was identified in the August IP3 newsletter and involved a two week field season measuring and collecting data including soil moisture, tree and vegetation density and stream depth, turbulence and water flow for the Sheep Creek Basin, which is a 500-square-kilometre watershed previously unstudied by hydrologists. As this region is facing forest growth and expansion along with increasing temperatures, this work will aid in predicting climate change effects on the water cycle in this area. Stacey's findings will contribute to the Cold Regions Hydrological Model (CRHM) by helping to understand what information is necessary to study watersheds within ungauged basins.



Measurements in Sheep Creek

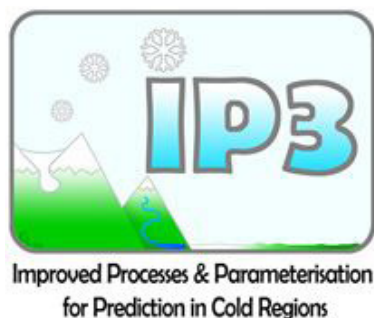
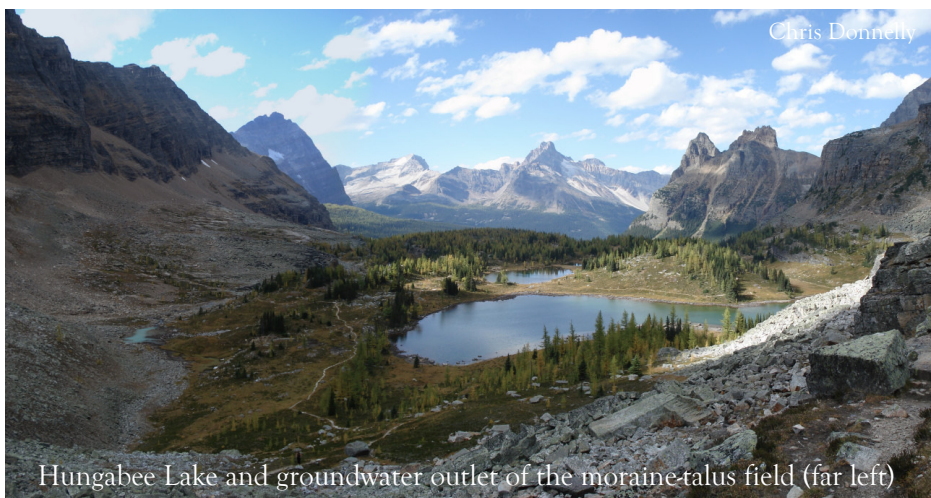
Ongoing Research

Modelling surface water–groundwater interaction in an alpine headwater catchment: Lake O’Hara, B.C.

Water resource decisions in Western Canada often require the application of large-scale hydrological models to complex mountainous landscapes. However, these models are often unable, or neglect, to deal with the extreme heterogeneity that often characterizes these regions. Furthermore, recent studies have indicated that coarse-grained surficial deposits regulate both the timing and quantity of peak streamflow from these watersheds. Research by Chris Donnelly, a grad student at the University of Calgary, has seen the development of a small-scale, surface water–groundwater flow model using field observations from the Lake O’Hara watershed in Yoho National Park, British Columbia. The watershed is segmented into hydrological response units (HRUs), each representing different land-cover, slope, aspect, and elevation band combinations.

After initializing the HRUs to maximum springtime snow water equivalent (SWE), a high-resolution meltwater flux to the subsurface is generated by independently performing snowmelt calculations for each HRU. Comparison between observed and simulated snowpack properties (mainly SWE and snow depth) at numerous locations within the basin verifies the accuracy of this flux. Due to the lack of soil and vegetation within the catchment, this flux percolates directly into a subsurface aquifer. The geometry and extent of this reservoir is constrained by a digital elevation model (DEM) derived from a light detection and ranging (LiDAR) survey of the area, hydrogeophysical measurements of bedrock depth, as well as air photo and field observation of spatial variations in land-cover and sediment type. Flow in the saturated zone and its interaction with

streamflow is then modelled using MODFLOW, a three dimensional finite-difference groundwater flow model. Validation of this subsurface flow model is based on the comparison between observed and simulated lake water levels and basin outflow. Ongoing studies hope to further refine this modelling approach; results will be used to corroborate hydrological processes and further constrain hydrological parameters determined through field study.



IP3 Outreach is available for setting up cold regions model training sessions or meetings between scientists and users for sharing of information. Informational brochures are available for public distribution, including brochures on IP3 research focused in the north, IP3 research in the mountain watersheds, and an overview of the Cold Regions Hydrological Model (CRHM) and its structure and specifications.



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