

NEWSLETTER

Improved Processes and Parameterisation for Prediction in Cold Regions



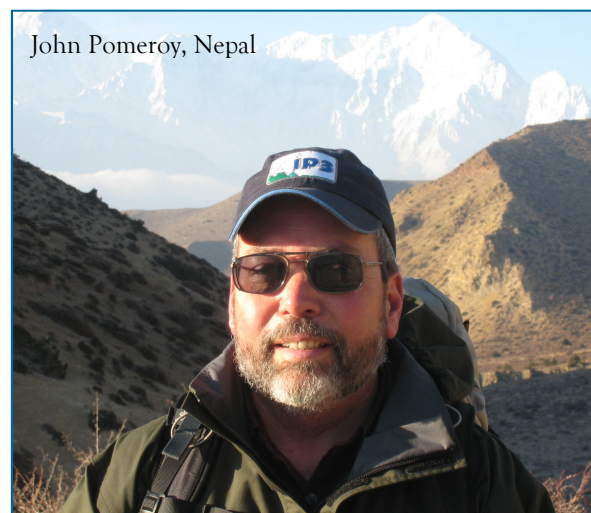
SEPTEMBER 2011

A final workshop was held in Saskatoon in early September signaling the end of the IP3 network and its mandate. The IP3 research network officially ends as of September 30th, 2011.

Message from the Principal Investigator

It is with satisfaction and sadness that I write to you in this last edition of the IP3 Newsletter. Satisfaction because IP3 has been such a wonderful experience and an honour to be involved with, and has done what it promised and more. Sadness because IP3 must now end as a funded network as does CFCAS (Canadian Foundation for Climate and Atmospheric Sciences) now end as a science funding organisation. CFCAS has been a complete pleasure to work with and has been much more than a funding organisation – it has been a valued partner in science and outreach and is a model for how a science funding foundation should operate. Canada was fortunate to have such visionary people leading it and will benefit for many years from the advances in science that have occurred with CFCAS support. IP3 was fortunate to have this support from CFCAS and the additional direct financial support from the International Polar Year, NSERC and the Governments of Alberta, Northwest Territories, Yukon, USA and UK amongst others.

IP3 made a brazen promise that over a short five years we could significantly improve our understanding of cold regions hydrological processes, describe these processes mathematically as parameterisations, and improve the performance of hydrological, meteorological and climatological models through the use of these parameterisations. Having a challenge like this is naturally exciting, and I feel that this ambitious plan has been realized through the tremendous hard work, energy and talent of our scientists, engineers, students and managers. They rose to the challenge and we now have a suite of very capable hydrological and land surface hydrology models that are being used to model large basins in Canada such as the South Saskatchewan and



Great Lakes, and smaller basins across Canada and throughout the world, from Chile to China, Spain to Switzerland. These models link with atmospheric models and in doing so free us from some of the constraints of limited surface observations and changing hydrology and climate, and in our ability to predict streamflow, soil moisture, frozen ground, lake dynamics, snowpacks and glacier melt. As with any science adventure we have ended up in a place that we did not intend. IP3 was not fundamentally a study to observe climate change, yet all investigators found dramatic changes occurring in their research basins; from rapidly declining permafrost cover, snowpacks and glaciers, to changes in hydrological regimes with streamflow increases in



the north and decreases in the south. The hydrometeorology of Canada's cold regions is changing as fast as we can understand it – this moving target doubled the challenge of IP3.

This has been a tremendously exciting adventure, from struggling through snow, sub-arctic muskeg, arctic tundra, steep terrain, insects, rough lakes, and extreme windchill to debugging complex computer programs, fixing electronic instrumentation, cleaning up massive datasets, conceptualizing new and very abstract ideas as mathematical models, to communicating effectively in our 15 network sponsored meetings. Through outreach we have tried to take new science to the people who can use it across western and northern Canada and we did more than we promised in all of this.

IP3 has been about people as well as science. It has been a network of many dozens of interesting and talented colleagues from around the world and a dynamic training ground for over 100 students. We have benefited from a devoted and skilled secretariat composed of Steen Westergaard, Julie Friddell, Nadine Kapphahn, Joni Onclin, Michael Allchin, Tom Brown, Edgar Herrera and Muluneh Mekonnen. They gave us the support we needed to complete the science and produced models, datasets, outreach, financial accountability and reports that we can be proud of. The Science Committee met over 50 times over the years and we should recognize the devotion, vision and diligence of Sean Carey (Theme 1 lead), Bill Quinton (Theme 2 lead), Al Pietroniro (Theme 3 lead) and Diana Versegby. Finally, IP3 had the wisdom, direction and insight from its Board of Directors: Bob Reid, Dan Moore, Vincent Fortin, Erica Wilson, Tim Aston, and Dawn Conway led by the remarkable Hok Woo. They were both demanding and inspiring and kept us on track.

So, focus on the science but never forget our humanity. That might be the final message of IP3.

Thanks for the memories.

John

Final Workshop

IP3 Triple Header Finale



Honourable Dustin Duncan

The IP3 Network Final Results Workshop was held at the National Hydrology Research Centre in Saskatoon on September 9th, 2011. The workshop was opened by the Honourable Dustin Duncan, Minister Responsible for the Saskatchewan Watershed Authority and Jim Basinger, Associate Vice-President Research at the University of Saskatchewan, followed by a welcome from Dawn Conway from the Canadian Foundation for Climate and Atmospheric Sciences (CFCAS). More than fifty people came to hear the network investigators present their summary findings from five years of work, highlighting the use of improved processes and improved parameterisations for use in improved models, along with the impacts and legacies of IP3. President MacKinnon of the University of Saskatchewan closed the meeting with his congratulations to John Pomeroy and the IP3 investigators for a very successful five years and the hope for future collaborations.



Dr. Jim Basinger



All presentations can be accessed from the IP3 website at <http://www.usask.ca/ip3/outrch.php> under the workshops tab, and presentations for the **IP3 Wrap-up Workshop**.

Some important results from the workshop included:

- The importance of funding research networks allowing large numbers of researchers to work together within a connected network structure to address large scale and very difficult science questions as a community.
- A physical legacy of fully instrumented research basins – for the short term some will continue to be used by universities for research while the responsibility for others will be maintained by various levels of government (regional, provincial or federal). The long term prospects for these basins remain unresolved.
- Parameters developed from process observations from one basin have been applied successfully to different basins.
- The many process studies used to create parameterisations – lake evaporation, blowing snow, sublimation, interception, snowmelt infiltration, and radiation effects on snowmelt.
- Groundwater roles in cold regions hydrology are not well known and need more research.
- The importance of measuring water and energy storage as a crucial governing factor for runoff response at the catchment scale.
- Energy inputs into the cold regions hydrological process needs more research.
- The development of new measuring technologies during the course of research; a multi-function heat-pulse probe, and a device for measuring snowpack properties using acoustics.
- Acknowledgment that a research focus can evolve from its original path upon finding new questions –research in one site started with a focus on hydrology, with permafrost becoming the central focus as new discoveries prompted looking in a new direction.
- Importance of IP3 in bringing together two philosophies of modelling – using MESH and CRHM as complementary modeling platforms – top-down and bottom-up.
- A shopping list for the future that includes the acknowledgement of regime changes – history does not necessarily dictate the future in hydrological processes in today's changing climate.
- The importance of embracing ecohydrology in future studies.
- A modelling legacy – parameterisations developed through IP3 research will continue to be incorporated into the MESH model by scientists at Environment Canada and the CRHM model by staff and graduate students at the Centre for Hydrology at the University of Saskatchewan. These models have been applied throughout western and northern Canada and South America, Europe, China and the United States.

Leading up to the workshop IP3 worked to advance the models and datasets so that they more fully incorporated the field research that operated in the first few years of the network. Recent advances in modelling include:

- Incorporation of frozen soil infiltration, and blowing snow transport and sublimation algorithms into the MESH model, permitting the application of MESH to the South Saskatchewan River Basin and Assiniboine River Basin with encouraging results.
- Incorporation of frozen soil thaw, canopy clearing and gap snowmelt, intercepted snow drip and energy balance based precipitation phase algorithms as new modules to CRHM, permitting its greater application in forest hydrology and permafrost hydrology.
- Development of an IP3 observational database that will be permanently archived at the University of Saskatchewan, Environment Canada and made available to outside groups such as the GeoCENS project at the University of Calgary and the Water and Environment HUB project in Alberta.



The IP3 Human Legacy

IP3 Graduates—Onward and Upward!

Student opportunities for both graduate and undergraduate research have allowed more than one hundred students to benefit from participation in IP3 funded research. Ten postdoctoral fellows, 26 PhD students, 39 MSc students and 34 undergraduate students along with a staff of research assistants and network administrators have supported the work of IP3 through its five year mandate. The success of these graduates highlights the importance of student funding support and how research operates as both a stepping stone and a catalyst for students in pursuing their own interests and careers using the knowledge their work within IP3 has given them. IP3 student coverage was truly national (and international!) in scope as evidenced by the variety of universities contributing students attended. A big thank you to the following students for sharing their postgraduate success.



PhD Students



Chad Ellis—(Marmot Creek) Chad completed his PhD (2011) on *Radiation and snowmelt dynamics in mountain forests* at the University of Saskatchewan, under the supervision of John Pomeroy. He is employed as a forest hydrologist at the Silvatech Group in central British Columbia, after a short stint as a Post-Doctoral Fellow at the University of Saskatchewan working for IP3 to complete the algorithms necessary for incorporating improved representation of infiltration in permafrost parameterisations in MESH.



AquaResource Inc.
Integrity • Technology • Solutions

Lucy Liu—(Scotty Creek) Lucy completed her PhD (2010) on *Improved interflow and infiltration algorithms for distributed hydrological models* at the University of Waterloo under the supervision of Ric Soulis. Lucy is currently working as a modelling specialist at AquaResource Inc. with duties involving; management and assessment of geologic, lithologic, and hydrogeologic data, GIS mapping and interpolation of hydrostratigraphic surfaces, and construction and calibration of 3D numerical groundwater models and/or integrated surface and groundwater models.



Cecile Menard—(Wolf Creek) Cecile completed her PhD (2010) on *Modelling the effects of shrub-tundra on snow and runoff* at the University of Edinburgh under the supervision of Richard Essery. She is currently working as a Post Doctoral Fellow at the University of Edinburgh on a NERC (Natural Environment Research Council) funded project titled *The response of Arctic regions to changing climate*. Her work mainly consists of improving model representation of the interactions between the soil and vegetation processes and improving surface model representation of snow and vegetation interactions.



Nicole Wright—(Scotty Creek) Nicole completed her PhD (2009) from Simon Fraser University; examining water and energy fluxes from a treed peat plateau in a wetland-dominated discontinuous permafrost basin to determine the factors controlling runoff generation from peat-covered permafrost slopes, under the supervision of Bill Quinton at Wilfrid Laurier University. Nicole is currently employed as an environmental scientist/hydrologist for Ecofish Research Ltd., an environmental consulting firm on Vancouver Island, B.C., where she designs, plans, and executes ecological studies focused on hydrology and aquatic resources, as well as assessing and certifying long-term monitoring for small-scale independent hydroelectric projects in British Columbia.

MSc Students



Jessica Boucher—(Wolf Creek) Jessica completed her MSc (2009) in *Exploring runoff processes using chemical, isotopic and hydrometric data in a discontinuous permafrost catchment* at Carleton University under the supervision of Sean Carey. She is currently employed in Geneva at the United Nations Environment Programme Finance Initiative (UNEP-FI) in their Biodiversity and Ecosystems Work Stream (BESWS) and their Water and Finance Work Stream (WFWS).



Laura Comeau—graduated with her MSc (2009) from the University of Saskatchewan under the supervision of Al Pietroniro and John Pomeroy, researching glacier contribution to the North and South Saskatchewan Rivers. Laura is now in her third year of a PhD at the University of Edinburgh with Richard Essery, modelling the impact of snow variations on Arctic populations in areas with limited data.



May Guan—(Baker Creek) May completed her MSc (2009) in *Shallow soil moisture–ground thaw interaction and controls* at the University of Saskatchewan under the supervision of Chris Spence. She is currently employed by the University of Saskatchewan and based at the Cold Water Collaborative in Canmore where May works as a research technician responsible for maintaining the field stations at Marmot Creek.



Greg Langston—(Lake O'Hara) Greg received his MSc (2010) from the University of Calgary, studying the internal structure and hydrological functions of a proglacial alpine moraine, working under the supervision of Masaki Hayashi. Greg is currently working as a research technician at Queen's University investigating the impacts of permafrost disturbance on hydrological, hydrochemical, and sediment fluxes in an arctic watershed.



Matt MacDonald—(Marmot Creek and Wolf Creek) Matt completed his MSc (2010) in *Blowing snow modelling in mountainous regions* through the incorporation of the Prairie Blowing Snow Model (PBSM) into MESH, under the supervision of John Pomeroy at the University of Saskatchewan. Key findings included the establishment of a method of distributing drifting snow between landscape units in mountainous terrain. Matt is just starting his PhD at the University of Edinburgh under the joint supervision of Richard Essery and John Pomeroy where he will be studying the effects of Chinook winds on the surface water balance.



Angela McLean—(Wolf Creek and Reynolds Creek) Angela completed her MSc (2009) in *Calibration and Optimization of the MESH hydrological model applied to cold regions*, under the supervision of Ric Soulis at the University of Waterloo. Angela is presently working in consulting in the Water Resources division of AECOM in Kitchener, Ontario working on a variety of projects including hydrology and hydraulic modeling, creek restoration, and environmental and hydrological fieldwork.

Many other IP3 students are still in the process of finishing their studies and will be “graduating” from IP3 in the next short while. Many new students are taking their place using the data collected through IP3 to continue the cycle of graduate research as part of the IP3 legacy.



IP3 Collaborators and their contributions

A strong and committed network of more than thirty collaborators from around the globe supported IP3 research with background work on supporting projects. Several collaborators shared summaries of the work they did in contributing to the overall research knowledge gained through the work of the IP3 community.

Stefan Pohl worked with Phil Marsh on a project that focused on improving the modeling of small scale snow cover ablation and meltwater runoff in an Arctic catchment. The project used the MESH model to simulate the annual spring melt over a 12 year period (1996-2008) of snow cover at Trail Valley Creek (TVC). The spring runoff at the basin outlet was simulated as well as the progression of the snow melt within the research basin.

- Initially the model was run with grouped response units (GRU's) that were based on vegetation only with GRU's identified as: open tundra, shrub tundra, sparse forest, and water.
- A second model run added two GRU's based on the distribution of snow within the basin throughout the winter. The addition of the GRU's did not considerably change the predicted snow runoff, however, the simulated basin average SCA now followed the observed one much closer during the early and later stages of the melt. The simulated spatial variability of the SCA was improved even though the model still underestimated it compared to the observed one.
- In a third run, GRU's were added to better simulate the differences in the snowmelt energy balance terms especially solar radiation during the melt process. The main land cover class of TVC (open tundra) was divided into three exposure classes: south facing, north facing, and flat tundra. The respective GRU's were given individual solar radiation inputs taken from the GEOtop model.
- The improvements of the simulation of the SCA shown in this study are important due to the strong influence of the snow cover on the energy exchange between the surface and the atmosphere.



Trail Valley snow survey

Uli Strasser (University of Graz, Austria) is researching snow cover dynamics in multiple research projects.

- WaterNPB**—The hydrological cycle in the area of the Berchtesgaden National Park is being analyzed with specific emphasis on the snow cover dynamics in the high alpine. The distributed hydrological model WaSIM-ETH is being applied, and a new snow module derived from AMUNDSEN should improve the modelling of water fluxes.
- MUSICALS**—The project MUSICALS aims to develop methods allowing the assessment of snow and ice melt discharge contributions into the alpine reservoir of the Kaunertal region (Austrian Alps) for multi-scale applications. The underlying snow- and ice melt as well as glacier fluctuation simulation models are designed to integrate physical process representation with data assimilation techniques to provide a robust, accurate and scenario-capable simulation tool, aiming for an optimised management of the reservoirs in the region.
- Glacier MEMO - Glacier Mass and Energy balance MOdelling at Freya Glacier (NE-Greenland)** - Glacier MEMO has been initiated to investigate the mass and energy balance of Freya Glacier, a small valley glacier in the north of Clavering Island (NE-Greenland, 74°30' N, 21°00' W). The model used for the numerical simulations is the physically based snow model AMUNDSEN which is appropriately parameterized and further developed within the framework of the project.



Freya Glacier, Greenland

Robert Schincariol and PhD student **Ranjeet Nagare** worked with Bill Quinton and Masaki Hayashi on mesocosm experiments using undisturbed peat cores sampled from the Scotty Creek watershed. The unique feature of these experiments was that the environmental chamber in the Biotron facility at the University of Western Ontario allowed for the maintenance of a frozen layer below a soil core that was subjected to freeze-thaw cycles. Major research activities in this project included:

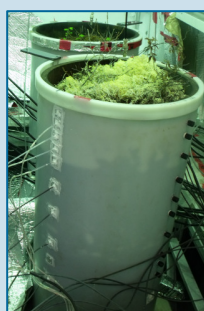
- Fully operational mesocosm experiments with four mesocosms being subjected to various freeze-thaw combinations to study active layer moisture dynamics.
- Study of effects of initial soil moisture profiles on freezing process of peat was investigated by maintaining the four mesocosms at different moisture profiles subjected to bi-directional freezing (from top and bottom). Frost induced soil moisture redistribution, effects of initial soil moisture profiles on such redistribution, and effects of initial soil moisture profiles on frost propagation were studied.
- Study of effects on initial moisture profiles on freeze and thaw processes in peat is being currently investigated. Thaw front movement, surface heat balance, and soil gas study are the major themes.



Sampling of the undisturbed peat cores in the Scotty Creek basin



Undisturbed core being inserted in experimental drums



Experimental setup before and after insulation



Chris Hopkinson and the **Applied Geomatics Research Group (AGRG)** in Nova Scotia participated in research at four of the IP3 watersheds (Peyto, Scotty, Marmot and Lake O'Hara) while supporting a variety of activities at the remaining watersheds by collecting, processing and providing airborne lidar data for digital elevation and canopy cover analyses.

- Lake O'Hara watershed research involved the derivation and comparison of the fundamental watershed attributes of extent, hypsometry and flow accumulation network across common DEM sources.
- At Peyto Creek, a GIS based energy balance model was run over Peyto Glacier at several DEM resolutions from 1m to 1000m. A long term study investigating the glacial and periglacial surface downwasting from 1949 to 2010, found that the proportion of ice cored lateral moraine extent relative to exposed glacier ice was increasing exponentially through time (Figure 1).
- AGRG also worked with John Pomeroy to investigate lidar snow depth sampling as a supplement to traditional snow coursing methods at Marmot and Elbow Creek watersheds. Work at Marmot explored spatial snowpack properties throughout the basin and demonstrated that snow depth increased up to tree line then decreased with increasing elevation above tree line where depth variability was greatest.
- Ongoing studies at Scotty Creek are attempting to quantify the insulating effects of vegetation overlying permafrost terrain by using lidar canopy height and fractional cover models to parameterise models of SW radiation, with follow up work directly comparing late season frost table depth with overlying and surrounding canopy cover at each measurement location.

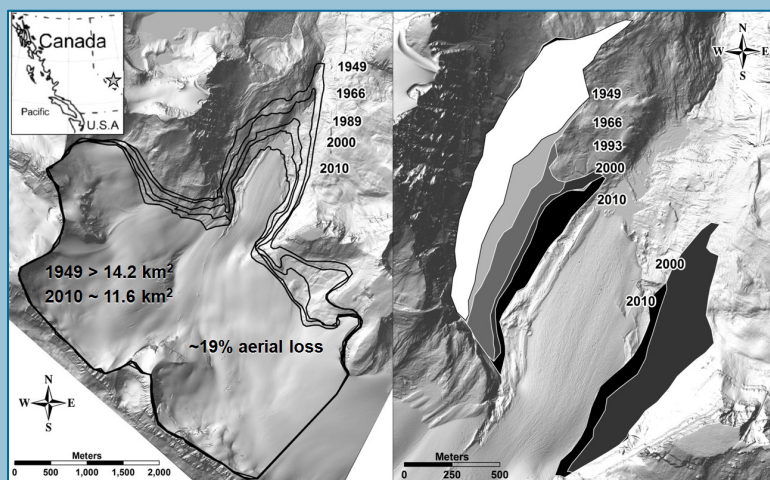


Figure 1.

An IP3 Modelling Legacy



Sharing knowledge with a wider audience was a strong theme within the IP3 network.

MESH workshops were held in Waterloo (2009), Edmonton (2009) and Saskatoon 2011; CRHM workshops were held in Waterloo (2008), Calgary (2008), Winnipeg (2009), Red Deer (2010), Yellowknife (2010) and Saskatoon (2011); a Users workshop was held in Canmore (2008); annual IP3 network workshops were held in Saskatoon (2006), Waterloo (2007), Whitehorse (2008), Lake Louise (2009—joint with WC²N), Ottawa (2010—concurrent with CGU), and Saskatoon (2011).

Coupled Hydrometeorological Modelling



The Hydrometeorological and Arctic Lab at Environment Canada and the Centre for Hydrology at the University of Saskatchewan continue collaborating to model a number of Canadian basins using standalone MESH, a coupled land-surface-hydrologic model that includes the Canadian Land Surface Scheme (CLASS) and WATFLOOD routing routines (WATROUTE). The project is research-based and aims to see how well the basin can be modelled using the latest version of standalone MESH and the Canadian Meteorological Centre's (CMC's) Global Environmental Multiscale (GEM) Numerical Weather Prediction (NWP) model and the Canadian Precipitation Analysis (CaPA) assimilated precipitation product.



The South Saskatchewan River Basin (SSRB) has been setup and initial model runs are promising. In particular, the incorporation of a frozen-soil infiltration algorithm has improved the prairie runoff simulations considerably during the spring-melt period.

The high-performance computer cluster at the National Hydrology Research Centre (NHRC) in Saskatoon has been setup to perform the calibration runs needed to select the appropriate parameters. In addition to the SSRB, work continues on a variety of basins, including the Upper Great Lakes, the Assiniboine basin, the Marmot Creek research basin in Kananaskis country, and Brightwater Creek, near Kenaston, about 100km south of Saskatoon. The Prairie Blowing Snow Model (PSBM) has been incorporated into an unreleased version of MESH and is being evaluated over the Marmot Creek research basin. Observations of surface fluxes and state variables at Kenaston are used to compare parameterisations developed from using observed in-situ meteorological forcing versus GEM/CaPA output.



In terms of technical administration, the model development team is beginning work to merge a variety of flavours of the MESH modelling system into one integrated modelling platform. Work is also underway to engineer a variety of model stress tests to ensure that new developments in the model code don't introduce bugs into the modelling platform. Software engineering management practices are continuing to improve the ability of the modelling team to expand its base to other government and university researchers who are improving the representation of physical processes and parameterizations.

Future work will include CMC's Global and Regional Ensemble Prediction Systems (GEPS and REPS) to characterize the uncertainty associated with the model, verify mesoscale ensemble precipitation forecasts through the analysis of hydrological observations, and improve the reliability of atmospheric and hydrologic 1 to 3 day forecast.

For more information: Contact Bruce Davison, Meteorological Services of Canada, at Bruce.Davison@ec.gc.ca

IP3 research has led to the publication of more than 90 refereed papers and over 50 other publications including books, book chapters and conference proceedings. Over two hundred presentations were given at conferences, workshops and public events by the IP3 community over its five year mandate.



Passing the Torch to the Users

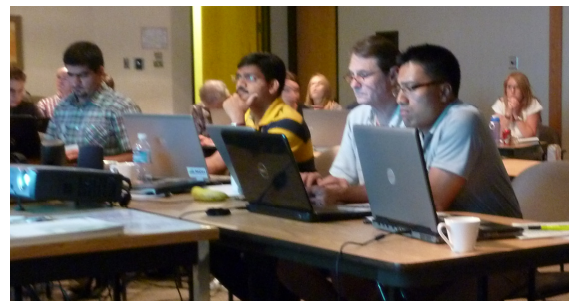


View of Baker Creek camp

The Baker Creek IP3 site has been integrated into the DIAND (Department of Indian and Northern Development) Water Resources local monitoring and research program, enhanced by Shawne Kokelj and Steve Kokelj of the Water Resources Division of INAC who have included permafrost and water quality components for monitoring. Chris Spence is continuing with his participation which is a legacy from the IP3 work in the Baker Creek Research Basin. The Scotty Creek Research Basin (Bill Quinton and Masaki Hayashi) will continue as a research partnership between the GNWT (Government of the Northwest Territories) Environment and Natural Resources Department and Wilfrid Laurier University as another legacy program evolving from IP3. These research partnerships will provide valuable knowledge essential for developing and maintaining information for water management in the Northwest Territories cold regions.

IP3 research was published in a HESS Special issue: Cold region hydrology: improved processes, parameterization and prediction which is available at http://www.hydrol-earth-syst-sci.net/special_issue105.html

A final CRHM workshop was held in Saskatoon on September 7th, 2011, attended by close to 30 participants from both academia and the private sector. As before each of the five previous CRHM workshops, the model had gone through some new upgrades and was well received by the attendees. CRHM support will continue to be offered through the Centre for Hydrology at the University of Saskatchewan, with information available for access from <http://www.usask.ca/hydrology/CRHM.php>.



The final IP3 sponsored MESH workshop was held on September 8th, 2011 at the National Hydrology Research Centre in Saskatoon. The event was chaired and organized by Bruce Davison (Environment Canada) with a varied group of presenters from both Environment Canada and the University of Waterloo. Information on MESH will continue to be available from the Centre for Hydrology website at <http://www.usask.ca/hydrology/MESH.php>.

The IP3 network website will be maintained by the University of Saskatchewan's Centre for Hydrology allowing access to historical materials including newsletters and informational materials along with contact information for IP3 researchers.

<http://www.usask.ca/ip3/>

A Permanent Legacy

Books to be Published on Network Research Outcomes

Two books aimed at popular and student audiences will be published in 2012 on the research outcomes of the IP3 and WC²N (Western Canadian Cryospheric Network) initiatives. Both books are being written by Bob Sandford and are expected to be published in the fall of 2012 by Rocky Mountain Books. The first book, titled *Cold Matters: The State and Fate of Canada's Freshwater* will focus on the impact of rising temperatures on Canada's cold regions including glacier melt, thawing permafrost, and the extent and character of changes in snow pack and snow cover in western and northern Canada. This book tells the story of the two research networks as one of discovery with over one hundred scientists and graduate students studying the changes occurring in the hydrological cycle in Canada. The importance of continued research as essential for improved ecosystem management, water management and water security as it relates to ensuring sustainable water supplies into the future will also be a topic explored in this book. The second book, titled *Storm Warning: Water & Climate Security in a Changing Canada*, will explore the public policy implications of the research outcomes generated by IP3, WC²N, and DRI (Drought Research Initiative, which were all funded by CFCAS (Canadian Foundation for Climate and Atmospheric Sciences). Writing these books has been a massive undertaking through the collection of research information from all the network scientists and collaborators, aided by Bob Sandford's attendance at a multitude of workshops and presentations.

For more information contact Bob Sandford
at Sandford@telusplanet.net



RMB | Rocky Mountain Books

The IP3 Data Archive

The IP3 archive has been established to allow data gathered by the network's participants to be available to the broader scientific community and general public. It contains some 30 million individual values, for 424 observation streams, from 44 stations in the seven main IP3 research basins.

This has been implemented through a web-based catalogue of consistently formatted and compressed text-files, which may be downloaded from the network's site at www.usask.ca/ip3/, under the 'Outputs / Data' tab.

This page provides several different options for finding data of interest:

- a "top-down" browse lists research basins, stations, and the observations associated with them.
- a basic search supports querying by observation sub-type or basin / station.
- the entire archive may be downloaded, as a Microsoft Access® database, together with the data-model's schema.
- there is also a PDF catalogue of datasets, organized by basin / station.

We hope that these options will serve the interests of a wide variety of users, and help to ensure that IP3 data continues to contribute to hydrological and other environmental scientific investigations for many years to come. Data can be accessed at <http://www.usask.ca/ip3/data.php>



Information in this issue submitted by Michael Allchin, Jessica Boucher, Laura Comeau, Bruce Davison, Chad Ellis, May Guan, Chris Hopkinson, Greg Langston, Lucy Liu, Matt MacDonald, Angela McLean, Cecile Menard, Ranjit Nagare, Stefan Pohl, John Pomeroy, Bob Reid, Bob Sandford, Uli Strasser, Nicole Wright, and Nadine Kapphahn

<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)