

# Changing Cold Regions Network

ISSUE #3  
MAY 2016

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## Message from the Principal Investigator

Dear CCRNers,

With 2 years to go, CCRN is in good shape to deliver and exceed our scientific targets. It's great to see the progress being made across the network, including the large efforts being made to maximize our field data for the SOAP initiative. High quality data are absolutely central to all our work, but depend on much hard work, under very demanding conditions, that is not always fully appreciated. However our data sets also make us a go-to place for leading international scientists, supporting NASA and World Climate Research Programme initiatives. Our special science initiatives are also bearing fruit, and the flood, drought and forest fires that have been the cause of so much suffering for our fellow Canadians are remarkable scientific opportunities that we are aiming to capitalize on – see the publications from the 2013 floods, below.

Looking to the end of our programme, much remains to be done to synthesize our science and to bring to bear our modelling developments to help guide Canada in meeting the changes we are seeing around us. However, we have encouraging news from NSERC. They have asked us for plans for a small amount of additional funding that will

help us disseminate our work and strengthen our data archive, and they are thinking actively about a new round of funding for the Climate Change and Atmospheric Research programme to provide some continuity of funding to maintain our scientific momentum.

I look forward to seeing many of you next week at CGU/CMOS, and of course at the exciting set of network workshops and meetings we have planned for rest of the year.

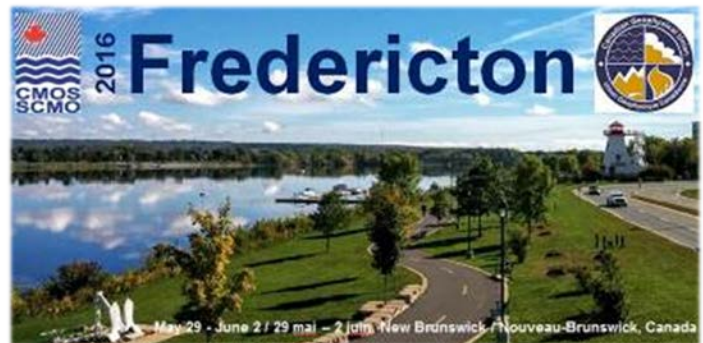
Regards,  
Howard



## **Upcoming Events**

### **CCRN at the 50<sup>th</sup> CMOS Congress & Joint CGU Annual Meeting, Fredericton, NB, 29 May–2 June, 2016**

The CCRN community will be engaged at the upcoming 50th CMOS Congress & Joint CGU Annual Meeting in Fredericton this spring. CCRN members are authors or co-authors on over 40 papers being presented, and the meeting will include a five-part session, “*Cold Regions Hydrology and Hydrometeorology*”, being convened by representatives from three of the NSERC Climate Change and Atmospheric Research networks: CCRN, CanSISE Network (<http://www.cansise.ca/>) and CNRCWP (<http://www.cnrcwp.uqam.ca/>).



- The conference website is <http://congress.cmos.ca/>
- A list of all papers by CCRN members can be found at <http://www.ccrnetwork.ca/news-events/news/2016/ccrn-involvement-at-the-2016-joint-cmos--cgu-meeting.php>

### **Cold Regions Hydrological Model (CRHM) Expert Workshop, Saskatoon, SK, 6–7 June, 2016**

CCRN is holding a workshop intended for those who are actively modelling or developing CRHM on our CCRN Water, Ecosystem, Cryosphere, and Climate (WECC) Observatories. The purpose is to report on progress, difficulties, and work up joint solutions for approaches to modelling complex basins and extending the capability of the model. It will also allow us to assess the progress in setting it up for the WECC observatories. One area of strong interest is in the new algorithms for frozen ground, hillslope hydrology with frost table, precipitation phase, avalanching snow and glaciers. We will also discuss interfacing it with reanalysis data and downscaled climate model products, data assimilation and basin GIS characterization. Then we will work up a plan for looking at diagnosing historical hydrological variability (using reanalysis) and moving towards diagnosing variability under future climates including extremes at the various WECCs.

Contact John Pomeroy ([john.pomeroy@usask.ca](mailto:john.pomeroy@usask.ca)) or Chris DeBeer ([chris.debeer@usask.ca](mailto:chris.debeer@usask.ca)) for further details.

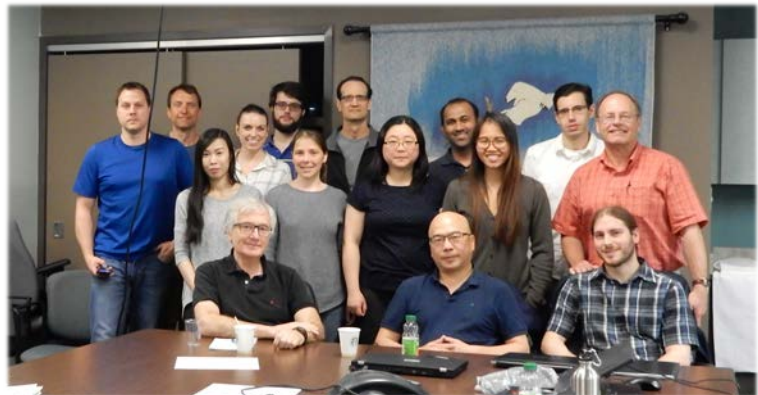
## Other Upcoming CCRN Workshops Planned for 2016

- CCRN Special Observation and Analysis Period (SOAP) Workshop, Saskatoon, SK (dates to be determined)
  - CCRN is proposing a two-day workshop this fall on the SOAP initiative (possible dates are in September 2016).
  - Participants would contribute presentations on various aspects of the SOAP year, including field observations, modelling results, anomalous events, etc., and the purpose would be to work towards a synthesis paper or collection of papers for a special issue journal.
  
- CCRN 4<sup>th</sup> Annual General Meeting, Guelph, ON, 2–4 November, 2016
  - The AGM will bring the network together to report on progress and plan future activities for the final year and beyond.
  - It will be held at the OAC Centennial Arboretum Centre, University of Guelph (<http://www.uoguelph.ca/arboretum/facilityrentals/>).
  - A block of guestrooms will be held at the Delta Guelph Hotel and Conference Centre up until 1 October, 2016 (<https://www.deltahotels.com/Hotels/Delta-Guelph-Hotel-and-Conference-Centre>). Reservations can be made by calling 519-780-3700 or 1-800-268-1133. Please identify yourself as being with the Changing Cold Regions Network.
  
- CCRN Modelling Workshop, Saskatoon, SK, 28–29 November, 2016.
  - This workshop will focus on model developments and progress toward modelling past and future change in our domain. It is also meant as a Theme B to D transition. More specific details have yet to be planned.

## Recent Workshops

### CCRN Theme D Workshop, University of Manitoba, Winnipeg, MB, 10–11 May, 2016

A Theme D workshop was held at the University of Manitoba earlier this month, hosted by Ron Stewart and John Hanesiak, which brought together a small core group of the atmospheric and hydrological scientists within CCRN and some of their students. The purpose of this workshop was to move towards the end of CCRN by exchanging insights, moving towards greater synthesis, identifying gaps and how to overcome them, and determining specific timelines to finish. Participants gave updates on their individual and collaborative research activities and recent progress, while focused discussions dealt with topics including collective work and syntheses on a variety of large-scale atmospheric–land surface issues, modelling and the representation of future climates, status and synthesis of a collection of papers on the Alberta 2013 flood to form a special journal issue, and some new insights into the large-scale conditions associated with the recent wildfires around Ft. McMurray, AB.



**Back row (from left):** Barrie Bonsal, Brock Tropea, John Hanesiak, Sopan Kurkute, Daniel Bentancourt.

**Middle (from left):** Chris DeBeer, Ida Hung, Hillary Smith, Julie Thériault, Yanping Li, Juris Almonte, Bob Kochtubajda.

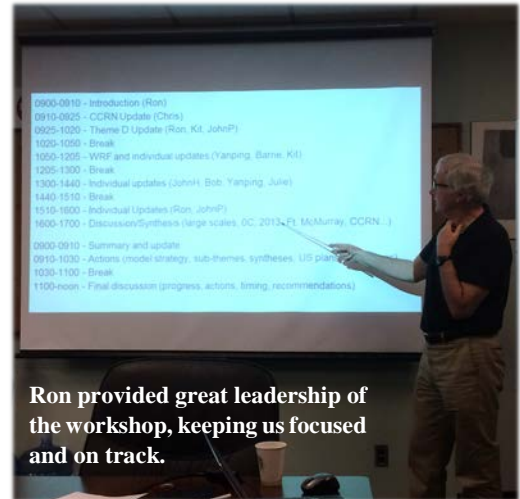
**Front (from left):** Ron Stewart, Kit Szeto, Sébastien Marinier.

**Missing:** John Pomeroy, Jennifer Bruneau.

This workshop was very productive and led to important outcomes that will be followed up as ongoing work over the remainder of the CCRN programme. Individual and collaborative work by the researchers in this group is progressing well and we largely are on track to meet our original goals. A number of other developments have been made. Yanping Li's team, working with NCAR, is producing 4 km WRF (Weather Research and Forecasting) model



climate simulations for the entire CCRN domain (14 years historical simulations, plus pseudo-warming simulations of future climate), which provides comparative data for Theme B, C, and D modelling and large-scale climate analysis. This work is well in hand and is expected to be completed towards the end of this summer. The collection of papers on the 2013 flood is beginning to come online—some earlier papers are already published—and while substantial progress has been made in understanding the events, there is a need to produce a synthesis paper on the atmospheric, hydrological, and hydraulic factors. More broadly, there is a need to contrast this with other similar events in North America and look into how the insights here apply. Plans to conduct a focal examination of the 0°C isotherm and its changes over western Canada were adopted by the group and actions going forward have begun to be implemented. This will address the questions, how and why has the 0°C isotherm been changing, how well do we understand and simulate this, how well can we anticipate future conditions, and what are the implications? It was also decided it would be worthwhile to continue to address recent extreme events and disasters in the CCRN geographic domain (e.g., recent droughts, floods, fire outbreaks, hazardous precipitation, etc.) and illustrate the chain of events leading up to these and the connections between them. We will need to focus on questions such as how are they changing, what is needed to handle these in models and how is this accounted for, what are the consequences on projections, and how do we communicate this to various audiences? Over the final two years of the CCRN programme, we need to consider some final statements we can make on large-scale change and limitations on our capabilities. Legacy products from Theme D were discussed, and some suggestions included a comprehensive synthesis of scientific and technical progress and outstanding issues, linking to specific articles and statements addressing key science issues.



**Ron provided great leadership of the workshop, keeping us focused and on track.**

The workshop was useful towards planning specific directions for the group leading up to our CCRN annual general meeting (AGM) in November in Guelph, ON. At the AGM, this group will present and discuss a detailed update on Theme D deliverables, special discussions of the large-scale focal research topics, and decisions on final products from the work. A report from this workshop will be available on our network website at [www.ccrnetwork.ca/science/workshops/theme-d-workshop-2016](http://www.ccrnetwork.ca/science/workshops/theme-d-workshop-2016) and presentations can be downloaded there as well.

**NASA's Arctic Boreal Vulnerability Experiment and POLAR Knowledge Canada Meeting, Whitehorse, YT, 16 May, 2016**

I recently returned from Whitehorse, Yukon, where along with checking on student trips, attended a meeting at Yukon College hosted by NASA's ABoVE program. Most CCRN folks will know something about ABoVE as Eric Kasischke serves on our international advisory panel and was in attendance, along with Chip Miller and Peter Griffith. The meeting was very well attended with approximately 20 people there, largely from the Yukon and Federal government. CCRN was represented by myself and Jill Johnstone, and there were a few other university-based researchers in attendance.

The meeting was a 'meet and greet' for NASA and Yukon-based researchers to exchange information and to see where synergies exist as to date there has been very little collaboration. Also, the meeting was held to discuss flight lines for upcoming aircraft missions flying a host of remote sensing platforms including all the latest LiDAR, multi-frequency radar and hyperspectral imagery as part of the ABoVE Foundational Airborne Measurements in 2017. The original flight lines proposed by ABoVE (which can be found on their webpage) missed much of the southern Yukon, and I believe that the people in the room successfully convinced NASA to adjust the flight lines so that the Alaska Highway corridor (including Wolf Creek) would be flown. No guarantees, but everyone in the room was adamant about this as most of the research in Yukon occurs along this corridor.

In addition, upcoming missions with new flight opportunities and novel facility instruments of NASA (LVIS, AVARIS) will occur over the next decade. For CCRN researchers, my understanding is that it would be best to contact the principal investigators of these payload focused instruments to develop a strong scientific project in association with ongoing CCRN WECC Observatories. I encourage all CCRN members to head to the ABoVE web page (<http://above.nasa.gov/>) and explore the projects that are already funded and future call for proposals. In addition, you can explore the possibilities of partnership with US researchers and developing affiliated project status. I get the strong sense that ABoVE would like to leverage existing and long-term data sets where possible, and while Canadian's cannot apply for funds directly, there is ample opportunity for partnership.

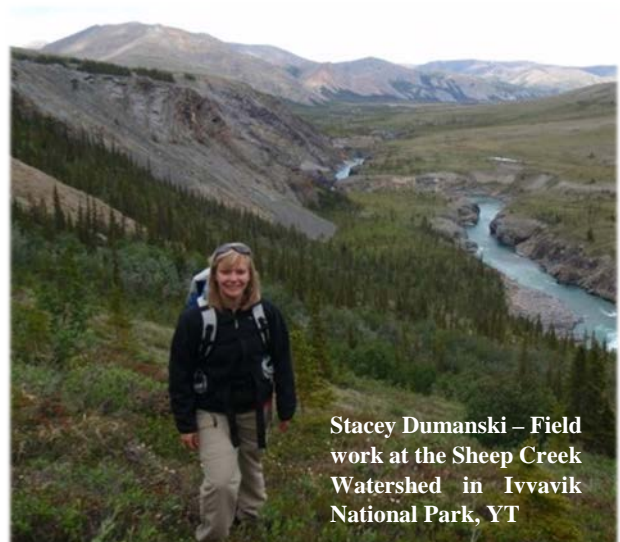
All in all I found it an encouraging meeting. There were lots of 'wishes' expressed but it was done in a spirit of collaboration and ongoing engagement. Again, I encourage CCRN researchers to explore the ABoVE webpage for future opportunities.

Sean Carey  
McMaster University

## **Announcements and Recent Publications**

### **New CCRN Outreach Coordinator, Stacey Dumanski**

This month Stacey Dumanski has joined us as the new CCRN outreach coordinator on a full-time basis. Stacey comes to us after completing a term position as Hydrologist and Water Quality Specialist with Environment and Climate Change Canada. Her background is in Physical Geography and Hydrology. She completed an MSc in Hydrology in 2015 under the supervision of professors John Pomeroy and Cherie Westbrook at the Centre for Hydrology, University of Saskatchewan, where she examined climatic and hydrological changes at Smith Creek in the eastern Prairies. Prior to that, she completed her BSc in Physical Geography at the University of Saskatchewan, obtaining a Specialty in Water Science. She has experience in working with and presenting material to various user groups in our domain, from the Prairies to the Rocky Mountains and the Yukon, as well as experience in working with the Cold Regions Hydrological Model. Stacey can be reached at [stacey.dumanski@usask.ca](mailto:stacey.dumanski@usask.ca).



Stacey Dumanski – Field work at the Sheep Creek Watershed in Ivvavik National Park, YT

### **Early Career Researchers Photo Contest – Submit Your Best Photos**

We want to see your best photographs! CCRN invites the Early Career Researchers to submit up to five photographs showcasing their research as a student or post-doc. Submissions will be organized into categories and voted on by fellow CCRN and Early Career Researchers this fall. Please submit your photos to Stacey ([stacey.dumanski@usask.ca](mailto:stacey.dumanski@usask.ca)) by August 31, 2016. Make sure to include a title and a brief description of the photograph. Prizes will be awarded at the 2016 AGM and we will feature all photographs on the website. Also, see our new Facebook page “[Changing Cold Regions Network](#)” and hit like to get updates to your newsfeed or post your own material. Looking forward to seeing your photos – Stacey Dumanski.

### **Theme A Review Paper on Observed Earth System Change in the CCRN Domain Published in HESS**

Theme A of our CCRN programme provides a synthesis of observed recent changes of the Earth system within the CCRN study domain and establishes the foundation of the project through the inventory, statistical evaluation, and

synthesis of these changes. Contributing to this Theme, a review paper has recently been published in the journal, *Hydrology and Earth System Sciences*. The paper provides a comprehensive review and up-to-date synthesis of the observed changes in air temperature, precipitation, seasonal snow cover, mountain glaciers, permafrost, freshwater ice cover, and river discharge over the interior of western Canada since the mid- or late 20th century. Important long-term observational networks and data sets are described, and qualitative linkages among the changing Earth system components are highlighted along with insights on process responses and interactions from various CCRN Water, Ecosystem, Cryosphere, and Climate (WECC) observatories.

- DeBeer, C. M., Wheeler, H. S., Carey, S. K., and Chun, K. P.: Recent climatic, cryospheric, and hydrological changes over the interior of western Canada: a review and synthesis, *Hydrology and Earth System Sciences*, 20, 1573–1598, doi:10.5194/hess-20-1573-2016, 2016. (<http://www.hydrol-earth-syst-sci.net/20/1573/2016/>)

### **Special Issue Papers on the 2013 Alberta Flood Coming Online**

The CCRN has conducted an in-depth, multi-disciplinary, and focal examination of the severe weather and flooding events that occurred in southwestern Alberta in June 2013. A stakeholder workshop was held in Canmore, AB in February 2014 ([www.ccrnetwork.ca/science/workshops/workshop-on-extreme-weather-and-hydrology](http://www.ccrnetwork.ca/science/workshops/workshop-on-extreme-weather-and-hydrology)) where it was decided that the network would proceed towards a collection of papers for a special issue journal, describing the flood and its meteorology, hydrology and hydraulics, and water management aspects. Seven papers have been submitted to the Special Issue Canadian Geophysical Union 2016 of *Hydrological Processes* and another to the *Journal of Hydrometeorology*, while four other recent papers present reviews and analyses on this flood. Stay tuned to our website ([www.ccrnetwork.ca](http://www.ccrnetwork.ca)) as more papers come online and are available.



**The Grande Rockies Resort (right) in Canmore—location of our workshop on the flood—seen in June 2013. Photo: Jonathan Hayward, Canadian Press.**

### **Hydrological Processes Special Issue Canadian Geophysical Union 2016 Papers**

- Fang, X., and Pomeroy, J. W.: Impact of antecedent conditions on simulations of a flood in a mountain headwater basin, *Hydrological Processes*, DOI: 10.1002/hyp.10910, 2016. (<http://onlinelibrary.wiley.com/doi/10.1002/hyp.10910/abstract>)
- Kochtubajda, B., Stewart, R. E., Boodoo, S., Thériault, J. M., Li, Y., Liu, A., Mooney, C., Goodson, R., and Szeto, K.: The June 2013 Alberta Catastrophic Flooding Event – Part 2: Fine-scale precipitation and associated features, *Hydrological Processes*, DOI: 10.1002/hyp.10855, 2016. (<http://onlinelibrary.wiley.com/doi/10.1002/hyp.10855/abstract>)
- Liu, A., Mooney, C., Szeto, K., Thériault, J. M., Kochtubajda, B., Stewart, R. E., Boodoo, S., Goodson, R., Li, Y., and Pomeroy, J. W.: The June 2013 Alberta Catastrophic Flooding Event: Part 1 – Climatological aspects and hydrometeorological features, *Hydrological Processes*, DOI: 10.1002/hyp.10906, 2016. (<http://onlinelibrary.wiley.com/doi/10.1002/hyp.10906/abstract>)
- Pomeroy, J. W., Fang, X., and Marks, D. G.: The Cold Rain-on-Snow Event of June 2013 in the Canadian Rockies – Characteristics and Diagnosis, *Hydrological Processes*, DOI: 10.1002/hyp.10905, 2016. (<http://onlinelibrary.wiley.com/doi/10.1002/hyp.10905/abstract>)

### **Hydrological Processes Special Issue Canadian Geophysical Union 2015 Paper**

- Harder, P., Pomeroy, J. W., and Westbrook, C. J.: Hydrological resilience of a Canadian Rockies headwaters basin subject to changing climate, extreme weather, and forest management, *Hydrological Processes*, 29, 3905–3924, 2015. (<http://onlinelibrary.wiley.com/doi/10.1002/hyp.10596/full>)



## Canadian Water Resources Journal Special Issue on Floods in Canada Papers

- Buttle, J. M., Allen, D. M., Caissie, D., Davison, B., Hayashi, M., Peters, D. L., Pomeroy, J. W., Simonovic, S., St-Hilaire, A., and Whitfield, P.: Flood processes in Canada: Regional and special aspects, *Canadian Water Resources Journal*, 41, 7–30, 2016. (<http://www.tandfonline.com/doi/full/10.1080/07011784.2015.1131629>)
- Pomeroy, J. W., Stewart, R. E., and Whitfield, P. H.: The 2013 flood event in the South Saskatchewan and Elk River basins: Causes, assessment and damages, *Canadian Water Resources Journal*, 41, 105–117, 2015. (<http://www.tandfonline.com/doi/abs/10.1080/07011784.2015.1089190>)
- Shook, K., and Pomeroy, J. W.: The effects of the management of Lake Diefenbaker on downstream flooding, *Canadian Water Resources Journal*, 41, 261–272, 2016. (<http://www.tandfonline.com/doi/full/10.1080/07011784.2015.1092887>)

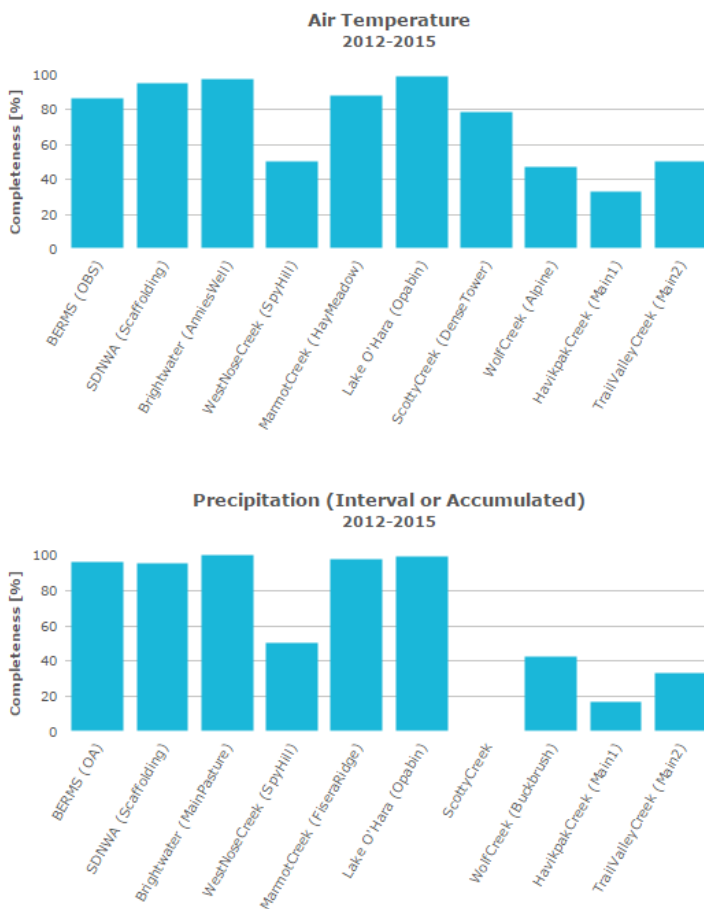
This CWRJ special issue contains many other relevant papers on floods in Canada and the CCRN geographic domain authored or co-authored by CCRN members (<http://www.tandfonline.com/toc/tcwr20/41/1-2>)

## CCRN Database Update

### Water, Ecosystem, Cryosphere, and Climate (WECC) Observatory Data

CCRN's data management system incorporates the records from our 14 WECC observatories and other sites within our geographic domain. CCRN members and others in the user community can access the meteorological, soil, flux, hydrometric and other data types via the web portal, web services or desktop clients—visit our website ([www.ccrnetwork.ca/outputs/data](http://www.ccrnetwork.ca/outputs/data)) or speak to our data manager, Branko Zdravkovic ([branko.zdravkovic@usask.ca](mailto:branko.zdravkovic@usask.ca)) for further instructions on how to access the data.

Every year, more data are being captured within the system and made available to the researchers thanks to the efforts of observatory managers, Principal Investigators, and research and technical personnel. Metadata on the CCRN database can be found at <http://giws.usask.ca/meta/>, where there are details about the field stations, observational variables, collection frequencies and periods as well as the completeness of the records that are available in the database. In addition to the detailed tabular representation of the collection statistics, various charts give a quick overview of the progress we have made so far in capturing the data from WECC observatories.



CCRN database statistics as of May 2016. See <http://giws.usask.ca/meta/reports/charts.html> for further details.

### Environment and Climate Change Canada (ECCC) Driving Data and Model Products

ECCC data that cover the CCRN research domain are available in ASCII, grib2, and ECCC standard (FST) formats by request to Dan Princz ([daniel.princz@usask.ca](mailto:daniel.princz@usask.ca)) or Bruce Davison ([bruce.davison@canada.ca](mailto:bruce.davison@canada.ca)). The GEM dataset contains hourly data for the seven forcing variables required by MESH/CLASS/SVS from 2002 to present at a 10 km or 15 km resolution. The CRCM5 dataset, provided to us by Laxmi Sushama, contains hourly data for the seven forcing variables required by MESH/CLASS/SVS from 1958-2014 at resolutions of 0.11, 0.22, and 0.44 degrees.

The CaPA (precipitation analysis) dataset contains 6-hourly and daily data for accumulated precipitation from 2002 to present at a 10 km resolution. The RDPS dataset contains 3-hourly data for four daily forecasts to 36 hours for all pressure fields from 2010/11/01 to present at a 10 km resolution. The HRDPS dataset contains hourly data, as well as half-hourly data for some variables, for four daily forecasts to 36 hours for all pressure fields from 2014/11/12 to present at a 2.5 km resolution. For further details on these products, see our website at [www.ccrnetwork.ca/outputs/data](http://www.ccrnetwork.ca/outputs/data).

### **Weather Research and Forecasting (WRF) Model Outputs**

High resolution (spatial and temporal) climate data in netcdf format has been generated for western Canada using the WRF model. The data has been available for the past climate (2000-2013) and future climate projections (equivalent to 2075-2099) using Pseudo-Global Warming (PGW) technique. The WRF post-processed dataset contains 2D/3D hourly and 3 hourly data for the seven forcing variables required by MESH and CLASS from Oct-2000 to Oct-2013 at a 4-km resolution. Apart from the seven variables, the WRF post-process data contains climate diagnostic variables, such as maximum and minimum, times when max and min occur, mean value, standard deviation of the mean for T2, Q2, TSK, U10, V10, 10 m wind speed, and rain, etc.

The dataset has been stored on the Global Institute for Water Security (GIWS) water-security server at the following location “/data2/NOBACKUP/sak298/Post\_processed”. This directory contains the past climate 2D, 3D and statistical datasets. The directories has been arranged based on the YYYY\_2D\_3D and YYYY\_1HR\_2D, where YYYY\_2D\_3D directory contains the 3 hourly 2D and 3D datasets for YYYY year and YYYY\_1HR\_2D contains the hourly 2D datasets. The future climate projections high resolution data has been stored at “/data2/NOBACKUP/sak298/Post\_processed\_PGW” and follows the similar nomenclature style mentioned above. For further details, please contact Yanping Li ([yanping.li@usask](mailto:yanping.li@usask)) or Sopan Kurkute ([kurkute.sopan@usask.ca](mailto:kurkute.sopan@usask.ca)).

### **Ongoing Research and Recent Outcomes**

#### **New conceptual model of groundwater in alpine headwaters: Fill, spill, and drain**

A fundamental understanding of the physical processes controlling groundwater contribution to stream flows is crucial in order to manage water resources effectively and understand how climatic changes will affect the hydrologic response of watersheds. However, the role of groundwater is poorly understood in alpine environments, and the physical processes are often oversimplified in hydrological models. The University of Calgary (UC) group, led by Masaki Hayashi, has been conducting field-based studies in the Lake O’Hara watershed in Yoho National Park since 2004, generating a substantial amount of knowledge and data. The synthesis of knowledge is facilitated by the use of hydrological models. Andrius Paznekas, a M.Sc. student funded by the CCRN used the Cold Regions Hydrological Model (CRHM) to create a hydrologic model of the Opabin sub-watershed (4.5 km<sup>2</sup>), within the Lake O’Hara watershed to provide insight into the storage mechanisms controlling consistent winter flows observed in alpine headwater streams. This was a collaborative effort between the CCRN researchers from the UC and the University of Saskatchewan (John Pomeroy and Logan Fang).



Stream gauging at one of the inflows to Lake O’Hara.

Modelled results show that surficial sediments (moraine, talus and alpine vegetation) contribute to winter baseflow but are not likely sustaining the consistent groundwater discharge. Despite their large storage capacities, the high hydraulic conductivities of these hydrogeomorphic units (moraine, talus, and alpine vegetation) limit storage at the end of the ablation period to less than 1% of the annual water balance. Modelled winter baseflow of less than 0.02 mm day<sup>-1</sup> (or 1 L s<sup>-1</sup>) grossly underestimated the discharge from the Opabin watershed (in the order of 10-20 L s<sup>-1</sup>),





Andrius conducting field work at the Opabin Glacier, Lake O'Hara Watershed.

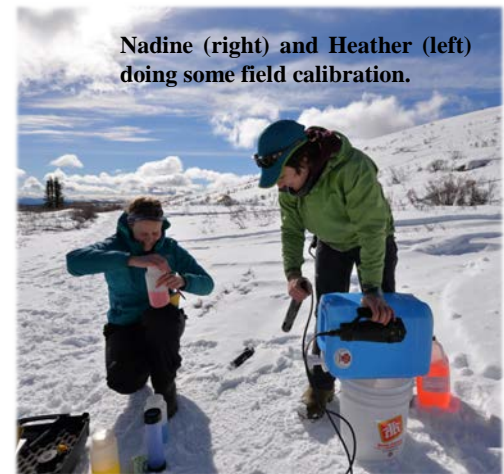
indicating that a secondary mechanism may be responsible for the consistent winter flows. Furthermore, modelled streamflow results demonstrated that inter-annual variability in the timing and magnitude of snowmelt did not affect winter baseflow. Also, the simplification of input parameters (snow water equivalent and incoming shortwave radiation) as well as climate change scenarios had little influence on winter baseflow. Evidence of bedrock fractures beneath the moraine by previous studies suggests that bedrock fracture flow may be the secondary mechanism providing groundwater discharge throughout winter. This follows a “fill, spill, and drain” conceptual model, where ample spring snowmelt and summer rainfall fills bedrock fractures/depressions each year, which then slowly release this

groundwater storage throughout the winter season providing consistent winter flows. It will be interesting to implement this fill-spill-drain process as part of the on-going development of the CRHM. Andrius successfully defended his M.Sc. thesis in April and is now working as a consulting hydrologist in Ottawa.

### **Ongoing Research and Field Activities at the Wolf Creek Research Basin, YT**

Wolf Creek Research Basin (located ~20km south of Whitehorse in Yukon Territory) has been a hub for various research initiatives over the past three decades and continues to be a base of operations for diverse research groups—and a focal observatory for the CCRN. PhD candidate, Nadine Shatilla (McMaster University) works with Sean Carey and the McMaster University Watershed Hydrology Group (<http://www.science.mcmaster.ca/watershed/>) to explore links between a changing subarctic climate, increased shrub cover at high elevations and the movement of water through permafrost soils in Granger Basin, a headwater catchment of Wolf Creek. Last month, the Watershed Hydrology Group (Heather Bonn, Renée Lemmond, Ryan Rolick, Nadine Shatilla) started a rigorous field season in 2016 with intensive campaigns aimed at developing a quantitative understanding of the processes that underlie how permafrost landscapes store, transport and release water in the context of a rapidly warming climate. Some research objectives in Wolf Creek Research Basin involve (1) using water chemistry and in-situ fluorometry to examine how thawing permafrost affects stream chemistry and dissolved organic carbon quantity and quality, (2) how permafrost soils affect water infiltration and movement along slope, (3) locating and quantifying groundwater inputs to headwater streams using FLIR® cameras and temperature sensors, (4) determining the relevance of the ‘2 water world’ hypothesis in the North, and (5) to fly a drone over Granger Basin for updated aerial imagery. The Watershed Hydrology Group is particularly interested in exploring how new technology can be used and adapted to help inform current conceptual models of how Northern catchments respond to a changing climate. The next step is to use an improved conceptual understanding to quantify catchment response to rapid climate warming using process-based models.

During May, Nadine, Heather and Renée were camping in the basin (with brief forays into Whitehorse for supplies and a dose of civilization) and experiencing the effects of a wet autumn in 2015, low winter precipitation and some of the earliest river ice breakups ever recorded. Ryan will arrive just after snowmelt to



Nadine (right) and Heather (left) doing some field calibration.



Granger Basin field camp, 2016.

start his fieldwork, and to prepare Wolf Creek Research Basin for a visit from researchers involved in the VeWa “Vegetation effects on water flow and mixing in high-latitude ecosystems” Project in late June, 2016. For more information on VeWa, please visit <http://www.abdn.ac.uk/geosciences/departments/geography-environment/vewa-640.php>.



*For more information or to contribute material for the next issue, please contact the Outreach Coordinator, Stacey Dumanski, at: [stacey.dumanski@usask.ca](mailto:stacey.dumanski@usask.ca)*