

Canadian Geophysical Union – Hydrology Section Committee Reports 2015

Hydroecology Committee

Chair: Daniel Peters (Environment Canada, University of Victoria) and Wendy Monk (University of New Brunswick).

Objective: To promote and advance the understanding of the linkages between hydrology and ecology in wetland, lake and river systems across Canada.

Northern Research Basins Committee

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The main activities of the CGU-HS Northern Basins Committee during the last year have been focused on preparing for the 20th Northern Research Basins Symposium and Workshop in Kuusamo, Finland, August 16 - 21, 2015. The main theme of the 20th NRB is “Value of Hydrological Information”. There will also be a Sub-Committee study report on the “Intercomparison of Solid Precipitation Measurement”. Details of the meeting can be found at: 20th-nrb@ymparisto.fi

As outlined in the NRB Mandate and the Canadian NRB Terms of Reference, Canadian delegates are invited by the Chief Canadian Delegate and approved by the CGU-HS Executive. The 2015 delegation represents a diversity of expertise in cold regions hydrology. The delegation includes representatives from the Yukon Territorial Government, Environment Canada, McMaster University and University of Victoria. Delegates also include two PhD students which will contribute to ensuring the long term viability of Canadian participation in the NRB.

The Canadian delegation to the 20th NRB in Kuusamo, Finland are listed below.

J Richard Janowicz, Yukon Department of Environment
Ming-ko Woo McMaster University
Terry Prowse, Environment Canada
Sean Carey, McMaster University
Brandi Newton, University of Victoria
David Barrett, University of Victoria

Information on the NRB and Canadian participation in the NRB can be found on the following site: www.canadiannrb.com

Contact Richard Janowicz at Richard.janowicz@gov.yk.ca for more information about the 20th NRB.

Urban Hydrology Committee

The goal of the CGU-HS Urban Hydrology Committee is to promote research activities related to urban ecohydrology in Canada and facilitate collaboration among researchers interested in the cumulative effects of climate change, land use and environmental management on urban hydrology and water quality. We are planning to convene an urban focused session at all future CGU meetings and welcome all interested parties to contact us to get involved.

Isotopic Tracers Committee

Committee Directorship

Trish Stadnyk (Chair), University of Manitoba

Jean Birks (past Chair), Alberta Innovates- Technology Futures, University of Waterloo

Tom Edwards, University of Waterloo

John Gibson, Alberta Innovates- Technology Futures, University of Victoria

Claude Hillaire-Marcel, GEOTOP-UQAM

Bernhard Mayer, University of Calgary

Fred Michel, Carleton University

Brent Wolfe, Wilfrid Laurier University

Background:

The CGU - HS Committee on Isotopic Tracers was originally established in 1997 to support and facilitate information exchange between isotope specialists and hydrologists both within Canada and internationally, and to address issues of importance to isotopic investigations including integration within broadly-based hydroscience research programs. In 2014, CGU Hydrology

Section dissolved all sub-committees, and re-established only those who were active, including the Isotope Tracer Committee. Recognizing and supporting promising applications of isotopic tracers, promoting cooperative research, providing information resources, and articulating research and educational needs to government agencies, universities, and the general hydrology community are the fundamental aims of the Committee.

Objectives and Activities:

The long-term objectives of the committee are to:

- promote and advance the understanding and application of isotopic tracer techniques in hydrology and related sciences
- initiate and participate in research and education programs
- maintain contact with relevant organizations
- report on national and international research activities, information sources, isotope monitoring networks, and databases
- establish working groups and/or subcommittees to assess specific, high-priority topics for research, monitoring and/or development, and
- disseminate current research and important findings to the scientific community via discussion, meetings and conferences, and publications

Progress on Issues and Objectives:

Tracer committee members continue to be active in the promotion and advancement of the understanding and application of isotopic tracer techniques in hydrology and related sciences. Of particular interest are the applications of isotope tracers to hydrometrics (Water Survey of Canada), in understanding precipitation processes and for regional, national and global networks that serve to build scientific capacity for tracer-based research. In May 2014 Tricia Stadnyk (University of Manitoba) took over from long-standing Chair Jean Birks as the new Chair of the the committee. We would like to acknowledge Jean's long-standing contributions and role as Chair and thank her for her service. Some highlights from 2014-15 include:

National & International Research Initiatives

The Water Survey of Canada, in cooperation with the University of Manitoba, University of Victoria, and Alberta Innovates Technology Futures, continues to support the national pilot of an operational isotope network in conjunction with their hydrometric network, similar the existing isotope-hydrometric network in the United States. The goal is to demonstrate the value in systematic collection of river discharge in tandem with analysis for oxygen-18 and deuterium across Canada. Water sampling of two hundred and seventy five key gauging stations commenced in May 2013. Further information can be obtained from John Gibson (jjgibson@uvic.ca).

Jean Birks wrapped up Canada's contributions to an International Atomic Energy Agency sponsored research program on "Use of Environmental Isotopes in Assessing Water Resources in Snow, Glacier, and Permafrost Dominated Areas under Changing Climatic Conditions". In collaboration with Tricia Stadnyk at the University of Manitoba, Canada, the first publication comparing results from several sites around the world was published in *Hydrological Processes* (Penna *et al.*, 2014) testing the representativeness of snow lysimeters, snow cores, and Frisbee samplers. For more information contact Jean Birks (jean.birks@albertainnovates.ca).

A team of members of the Isotope Tracer Committee of the Canadian Geophysical Union is participating in an International Atomic Energy Agency (IAEA) Coordinated Research Project (CRP F33021) entitled: Application and Development of Isotope Techniques to Evaluate Human Impacts on Water balance and Nutrient Dynamics of Large River Basins. The Canadian project, initiated in April 2014 and entitled *Isotope Tracing of Human Impacts on Water Balance and Nutrient Dynamics of Large Canadian River Basins*, is Coordinated by Jean-François Hélie (Geotop-UQAM), supported by John Gibson (University of Victoria & AITF) and Claude Hillaire- Marcel (Geotop-UQAM). Six teams from across Canada support this Canadian CRP and are led respectively by Jean-François Hélie, John Gibson, Trish Stadnyk, Ian Clark, Fred Longstaffe and David Soto. The CRP aims at coordinating Canadian efforts in assessing human impacts on large river systems using isotope tracers. A first team Canada meeting was held during the 2014 May CGU meeting to coordinate efforts and discuss sampling strategies. In October 2014, Jean- François Hélie, John Gibson and Claude Hillaire-Marcel represented team Canada during first IAEA CRP F33021 meeting in Vienna. For information contact Jean Francois Hélie (helie.jeanfrancois@uqam.ca).

A special session entitled "Isotopic Tools to Assess Human Impacts on Large River Systems" will be held at the upcoming AGU-CGU Joint Assembly during 3-7 May 2015 in Montreal. Most large river systems in the world are being impacted by human activities. Such activities include,

but are not restricted to deforestation, waste water discharge, damming & flooding, agricultural intensification, etc. In order to mitigate these impacts, we need tools to assess the source of such disturbance in order to decipher natural from anthropogenic influences from anthropogenic activities. This session will focus on the use of isotopic tracer techniques in studies trying to assess human impacts on large rivers systems. We encourage all isotopic systems (traditional & non—traditional stable, radiogenic, cosmogenic and noble gases isotopes) in water, nutrients and sediments. For information contact session Chair Jean Francois Hélie (helie.jeanfrancois@uqam.ca).

This year there will be an International Symposium on Isotope Hydrology entitled “Revisiting Foundations and Exploring Frontiers” that several of our Canadian isotope hydrologists will be attending and participating in from 11-15 May. Details on the symposium and presentations can be found at <http://www-pub.iaea.org/iaeameetings/46527/International-Symposium-on-Isotope-Hydrology-Revisiting-Foundations-and-Exploring-Frontiers>, contact Len Wassenaar (l.wassenaar@iaea.org).

There is a special issue on isotope tracers currently in preparation for publication in *Hydrological Processes* (Editors McGuire and McDonnell). For more information, contact co-editor Jeffrey McDonnell (jeffrey.mcdonnell@usask.ca).

Regional Research Initiatives

We recently published our tracer paper (in press) on the isotope tracers we've used for the Bruce site for low and intermediate level radioactive waste. It focuses on the isotopes of methane and CO₂ in tracing the origin of biogenic gas in a deep aquiclude, and complements an earlier paper that focused on helium in this aquiclude. Stable isotopes provide the basic understanding of the porewater origin in the Paleozoic shales of this aquiclude (Clark et al 2013; 2015). Two graduate students are expanding our studies at this site: Sarina Cotroneo (PhD candidate) is looking at ⁴⁴Ca and ²⁶Mg tracers of brine-rock interactions and dolomitization, and Laurianne Bouchard (MSc candidate) is looking at ⁸⁷Sr ingrowth to constrain the age of the brines in these rocks (research funded by Nuclear Waste Management Organization in Toronto). Dr. Ian Clark is also publishing an undergraduate textbook, *Groundwater Geochemistry and Isotopes* aimed as an entry level text for students and practitioners to learn the basics and get started using isotope tracers (due for release summer 2015 by CRC Press). For more information, contact Dr. Ian Clark (idclark@uottawa.ca).

Out of Wilfred Laurier University in Waterloo, ON, Dr. Brent Wolfe is utilizing isotope tracers in water ($\delta^{18}\text{O}$, $\delta^2\text{H}$), dissolved inorganic carbon ($\delta^{13}\text{C}$) and sediment ($\delta^{13}\text{C}_{\text{organic matter}}$, $\delta^{15}\text{N}$, $\delta^{18}\text{O}_{\text{cellulose}}$) of lakes and rivers in northern lake-rich landscapes to identify the consequences of climate change and increasing avian populations on aquatic ecosystems. Research is mainly focused on ecologically-significant regions of northern Yukon Territory (Old Crow Flats / Vuntut National Park) and northern Manitoba (Wapusk National Park). Parks Canada has adopted the use of water isotope tracers into their aquatic ecosystem monitoring program for Vuntut National Park; 2015 will be the 4th year of operation, building on a 5-year dataset obtained during the International Polar Year Program. Wapusk National Park has also committed to employing isotope techniques for hydroecological monitoring of lakes and fieldwork in 2015 will focus on training Parks Canada staff in these methods. For more information, contact Dr. Brent Wolfe (bwolfe@wlu.ca).

From the University of Manitoba Water Resources Engineering (Hydrology) group, work on North American isoscapes was recently featured in Water Resources Research (Delavau et al., 2015). The models developed represent a considerable improvement on the resolution of mapped isotopes in precipitation across Canada over the previous CNIP interpolations, and have extensive applications in isotope hydrology including spatially distributed time-series hydrologic modelling. Results from the lower Nelson River basin isotope monitoring program established in tandem with hydrometrics were recently published in the Canadian Water Resources Journal (Smith et al., 2015). Regional isotope sampling is on-going in lower Nelson River basin, and is being extended through another project (BaySys) into Hudson Bay over the next four years.

Out of Saskatoon, Dr. Chris Spence and others involved in the Changing Cold Regions Network's Special Observation and Analysis Period (SOAP) are involved in sampling for isotopes at a network of research catchments across western and northern Canada to better understand runoff pathways, and water sources for different parts of the water cycle. For more information, contact Drs. Chris Spence or Jeff McDonnell (chris.spence@ec.gc.ca, jeffrey.mcdonnell@usask.ca).

Members of AITF have been involved in a wide variety of research projects in 2014-15 involving application of isotopic and geochemical tracers. Some of the major research projects include isotopic tracing of evaporation and evapotranspiration, tracing of saline inputs to the Athabasca River in the oil sands region, isotope mass balance of lakes and watersheds in BC, Alberta, Northwest Territories, Nunavut, Alaska, and continental USA, isotope mass balance of the Great Lakes, boreal wetland hydrology and geochemistry, tracing of municipal effluent, geochemical effects of steam-assisted gravity drainage, and multi-tracer approaches for tracing industrial water in the oil sands region. For more information, contact Dr. John Gibson of AITF Victoria (jjgibson@uvic.ca).

And from the Yukon Territories, The Northern Climate ExChange (part of the Yukon Research Centre at Yukon College) and the Yukon River Intertribal Watershed Council have been working together to analyze a set of water isotope data the Watershed Council has been collecting from the Yukon River watershed via its Indigenous Observation Network. The project involves working with a dataset of +130 samples (mostly collected in 2008 and 2009) and developing frameworks within which to examine sample results for subsequent years (samples not yet analyzed). More details and a project report are available at http://yukoncollege.yk.ca/research/project/yukon_river_water_isotope_data_interpretation_of_canadian_indigenous_observ. The Northern Climate ExChange is also working with Yukon Energy Corporation to assess the impacts of climate change on snow and glacier dynamics in the headwaters of the Yukon River, and subsequent implications for hydrosecurity. The project involves developing hydrological and glacial models for the headwater region, complemented by a water isotope tracer component. Samples from across the headwaters are being collected and analyzed to support identification of relative roles of headwater hydrological processes on downstream discharge. More information about this project is available at http://yukoncollege.yk.ca/research/project/characterizing_hydrological_processes_in_the_headwater_region_of_the_yukon.

Recent Publications by Committee membership:

Balasubramaniam AM, RI Hall, BB Wolfe, JN Sweetman and XA Wang. 2015. Source-water inputs and catchment characteristics regulate limnological conditions of shallow Arctic lakes (Old Crow Flats, Yukon, Canada). *Canadian Journal of Fisheries and Aquatic Sciences* (in press).

Bouchard F, KW Turner, LA MacDonald, C Deakin, H White, N Farquharson, AS Medeiros, BB Wolfe, RI Hall, R Pienitz and TWD Edwards (2013). Vulnerability of shallow subarctic lakes to evaporate and desiccate when snowmelt runoff is low. *Geophysical Research Letters* 40: 6112-6117.

Brooks, J.R., Gibson, J.J., Birks, S.J., Weber, M., Rodecap, K., Stoddard, J.L., (2014). Stable isotope estimates of evaporation: inflow and water residence time for lakes across the United States as a tool for national lake water quality assessments, *Limnology and Oceanography*, in press.

Clark, I.D., Al, T., Jensen, M., Kennell, L., Mazurek, M., Mohapatra, R., and Raven, K.G., (2013). Paleozoic-aged brine and authigenic helium preserved in an Ordovician shale aquiclude. *Geology*, 41: 951-954.

Clark, I.D., Ilin, D., Jackson, R.E., Jensen, M., Kennell, L., Mohammadzadeh, H., Poulain, A., Xing, Y.P. and Raven K.G. (2015). Paleozoic-aged microbial methane in an Ordovician shale and carbonate aquiclude of the Michigan Basin, Southwestern Ontario. In Press, *Organic Geochemistry*.

Delavau, C, K. P. Chun, T. Stadnyk, S. J. Birks and J. M. Welker et al (2015). North American precipitation isotope ($\delta^{18}\text{O}$) zones revealed in time series modeling across Canada and northern United States. *Water Resources Research*, doi: 10.1002/2014WR015687

Fraser, E.C., Miller, J.F., Longstaffe, F.J. and Fenton, M.B. (accepted) Systematic variation in the stable hydrogen isotope ($\delta^2\text{H}$) composition of fur from summer populations of two species of temperate insectivorous bats. *Mammalian Biology*, 28 ms pages, 1 table and 3 figures.

Gibson, J.J., Birks, S.J., Yi, Y. (accepted). Stable isotope mass balance of lakes: a contemporary perspective. *Quaternary Science Reviews*, accepted 12 April 2015.

Gibson, J.J., Birks, S.J., Yi, Y., Vitt, D. (accepted). Runoff to boreal lakes linked to land cover, watershed morphology and permafrost melt: a 9-year isotope mass balance assessment. *Hydrological Processes*, accepted 27 March 2015.

Gibson, J.J., Reid, R. (2014). Water balance along a chain of tundra lakes, *Journal of Hydrology* 519, 2148-2164.

Herod, M.N., Clark, I.D., Cornett, R.J., Kieser, W.E., St. Jean, G. (2014). Extraction of ^{129}I and ^{127}I via combustion from organic rich samples using ^{125}I as a quantitative tracer. *J. Environ. Radioactivity*, S0265-931X(14)00037-X. doi: 10.1016/j.jenvrad.2014.02.005

Hundey, E.J., Moser, K.A., Longstaffe, F.J., Michelutti, N. and Hladyniuk, R. (2014). Recent changes in production in oligotrophic Uinta Mountain lakes, Utah, identified using paleolimnology. *Limnology and Oceanography*, v. 59(6), p. 1987-2001.
http://aslo.org/lo/toc/vol_59/issue_6/1987.pdf

- Jasechko, S., Gibson, J.J., and Edwards, T.W.D. (2014). Stable isotope mass balance of the Laurentian Great Lakes. *Journal of Great Lakes Research* 40, 336-346. doi: 10.1016/j.jglr.2014.02.020
- Jasechko, S., Sharp, Z.D., Gibson, J.J., Birks, S.J., Yi, Y., Fawcett, P.J. (2014). Brief Communications Arising, Reply to A. M. J. Coenders-Gerrits et al., Uncertainty in Evapotranspiration Rates, *Nature* 506, E2–E3 (13 February 2014), doi:10.1038/nature12926.
- MacDonald LA, N Farquharson, G Merritt, S Fooks, RI Hall, BB Wolfe, ML Macrae and J Sweetman (2015). Limnological regime shifts caused by climate warming and Lesser Snow Goose population expansion in the western Hudson Bay Lowlands (Manitoba, Canada). *Ecology and Evolution* 5: 921-939.
- MacDonald LA, N Farquharson, RI Hall, BB Wolfe, ML Macrae and JN Sweetman (2014). Avian-driven modification of seasonal carbon cycling at a tundra pond in the Hudson Bay Lowlands (northern Manitoba, Canada). *Arctic, Antarctic, and Alpine Research* 46: 210-224 (special issue on *Environmental Change in the Hudson and James Bay Region, Canada*).
- Medeiros AS, DJ Taylor, M Couse, RI Hall, R Quinlan and BB Wolfe (2014). Biological and nutrient responses to catchment disturbance and warming in small lakes near the Alaskan tundra-taiga boundary. *The Holocene* 24: 1308-1319.
- Metcalfe, J.Z. and Longstaffe, F.J. (2014). Environmental change and seasonal behaviour of mastodons in the Great Lakes region inferred from stable isotope analysis. *Quaternary Research*, v. 82, p. 366-377. <http://dx.doi.org/10.1016/j.yqres.2014.07.002>
- Penna D, M. Ahmad, S. J. Birks, L. Bouchaou, M. Brenčič, S. Butt, L. Holko, G. Jeelani, D. E. Martínez, G. Melikadze, J. Shanley, S. A. Sokratov, T. Stadnyk, A. Sugimoto, P. Vreča (2014). A new method of snowmelt sampling for water stable isotopes. *Hydrol. Processes*, 28(22): 5637-5644. doi: 10.1002/hyp.10273.
- Skrzypek G., Mydlowski A., Dogramaci S., Hedley P., Gibson J., Grierson P., (2015). Estimation of evaporative loss based on the stable isotope composition of water using "Hydrocalculator". *Journal of Hydrology* (HYDROL18197 accepted 5/02/2015).
- Skuce, M., Longstaffe, F.J., Carter, T.R. and Potter, J. (2015). Isotopic fingerprinting of groundwaters in southwestern Ontario: applications to abandoned well remediation. *Applied Geochemistry*, 58: 1-13. <http://www.sciencedirect.com/science/article/pii/S0883292715000566>
- Smith A, Delavau C., Stadnyk TA (2015). Hydrologic Assessment of the lower Nelson River basin using stable water isotope investigations. *Can. Water Resour. J.*,40(1): 23-25. doi: 10.1080/07011784.2014.985512
- Stadnyk T., Delavau C., Kouwen N., Edwards T.W.D. (2013). Towards hydrological model calibration and validation: simulation of stable water isotopes using the isoWATFLOOD model. *Hydrol Processes*, 27(25): 3791-3810.
- Stadnyk, T.A., Gibson, J.J., Longstaffe, F.J. (2014). Basin-Scale Assessment of Operational Baseflow Separation Methods. *Journal of Hydrologic Engineering*, doi: 10.1061/(ASCE)HE.1943-5584.0001089.

Tondu J-ME, KW Turner, BB Wolfe, RI Hall, TWD Edwards and I McDonald (2013). Using water isotope tracers to develop the hydrological component of a long-term aquatic ecosystem monitoring program for a northern lake-rich landscape. *Arctic, Antarctic, and Alpine Research* 45: 594-614.

Turner KW, BB Wolfe, TWD Edwards, TC Lantz, RI Hall and G Larocque (2014). Controls on water balance of shallow thermokarst lakes and their relations with catchment characteristics: A multi-year, landscape scale assessment based on water isotope tracers and remote sensing in Old Crow Flats, Yukon (Canada). *Global Change Biology* 20: 1585-1603.

Turner KW, TWD Edwards and BB Wolfe (2014). Characterising runoff generation processes in a lake-rich thermokarst landscape (Old Crow Flats, Yukon, Canada) using $\delta^{18}\text{O}$, $\delta^2\text{H}$, and d-excess measurements. *Permafrost and Periglacial Processes* 25: 53-59.

Turner, K.W., Edwards, T.W.D., and Wolfe, B.B. (2014). Characterizing runoff generation processes in a lake-rich thermokarst landscape (Old Crow Flats, Yukon, Canada) using $\delta^{18}\text{O}$, $\delta^2\text{H}$, and d-excess measurements. *Permafrost and Periglacial Processes* 25, 53-59. doi: 10.1002/ppp.1802

White J, RI Hall, BB Wolfe, EM Light, ML Macrae and L Fishback. (2014). Hydrological connectivity and basin morphometry influence seasonal water-chemistry variations in tundra ponds of the northwestern Hudson Bay Lowlands. *Arctic, Antarctic, and Alpine Research* 46: 225-243 (*special issue on Environmental Change in the Hudson and James Bay Region, Canada*).

Yi, Y., Gibson, J.J., Birks, S.J., Han, J., Borchers, C.H., (2014). Comment on “Profiling oil sands mixtures from industrial developments and natural groundwaters for source identification”. *Environmental Science and Technology* 48, 11013-11014, dx.doi.org/10.1021/es503498p.

Yi, Y., Birks, S.J., Cho, S., Gibson, J.J., (2015). Characterization of organic composition in snow and surface waters in the Athabasca oil sands region, using ultrahigh resolution Fourier transform mass spectrometry. *Science of the Total Environment*, (STOTEN-D-14-03720R1 accepted 6/02/2015