



**Proceedings of the
70th ANNUAL**

EASTERN SNOW CONFERENCE

4-6 June 2013

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Ontario, Canada

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Proceedings of the Eastern Snow Conference

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FOREWORD

This proceedings volume contains papers presented at the 70th Eastern Snow Conference (ESC) held 4–6 June 2013, at the Active Living Center, Huntsville Ontario, Canada. The meeting featured 6 sessions on: advances in snow modeling, snowfall patterns and trends, watershed hydrology, remote sensing, snow measurements: instruments and techniques, and climate change impacts on snow and ice.

The ESC is a joint United States and Canadian forum for discussing recent work on operational, applied and scientific issues related to snow and ice. It also retains an increasing interest as a symposium where novel approaches to cryospheric science of international significance are presented. The ESC has published an annual series of proceedings since 1952. Membership in the ESC is open to all interested individuals and corporations. Additional copies of the current proceedings and all back issues can be obtained from the Canadian Secretary. Additional information about the Eastern Snow Conference may be found at: <http://www.easternsnow.org/>.

We continue with an optional review process, and authors may submit extended abstracts or full papers to these Proceedings. Participants in the Western Snow Conference (WSC— <http://www.westernsnowconference.org/>) were invited to join the ESC participants in the option to submit papers relevant to winter hydrology to the international journal, *Hydrological Processes*. These papers went through a formal journal review, revision, and referee process and many appear both in these proceedings and in the journal. Mauri Pelto (Nichols College), Richard Kelly (University of Waterloo), and Kelly Elder (USFS, Ft. Collins), edit this special issue of *Hydrological Processes* dedicated to ESC/WSC papers.

Unfortunately, we have to report here that after many, many years of support, particularly in the production of these Proceedings, CRREL has ceased being a Corporate Member. In part this explains the delay in providing you with these Proceedings. Our apologies to everyone for the delay in producing and shipping this volume. We are grateful to all of CRREL personnel who have attended our meetings over the decades, and many have been an integral part of the ESC including serving in the Executive. We hope that at some point in the not-too-distant future, we will see you at our meetings once again. To those who have given unstintingly their time and expertise in the production of our Proceedings our sincere thanks and gratitude.

We acknowledge, with gratitude, Mr. Stephen Gardiner, Trent University for his expertise in helping produce this volume. Lastly, we recognize our Corporate Members below, who generously support our meetings and in doing so improve the ESC immeasurably. Thank you.

We look forward to seeing many of you at the 71st Eastern Snow Conference meeting to be held 3–5 June 2014 at Appalachian State University, Boone, North Carolina, USA. This will be our southernmost meeting ever, and it promises to be an exceptional one, where the general theme will be “Snow and Ice in Mountain Environments”.

Alex Langlois & 2012-13 ESC Executive

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STATEMENT OF PURPOSE

The Eastern Snow Conference (ESC) is a joint Canadian/US organization founded in the 1940s, originally with members primarily from eastern North America. Our current members are scientists, snow surveyors, engineers, technicians, professors, students, and operational and maintenance professionals from North America, the United Kingdom, Japan, and Germany. There is a western counterpart to the ESC, the Western Snow Conference (WSC), which also is a joint Canadian/US organization. Every fifth year, the ESC and the WSC hold joint meetings.

The Eastern Snow Conference is a forum that brings the research and operations communities together to discuss recent work on scientific, applied, and operational issues related to snow and ice. The location of the conference alternates yearly between the United States and Canada, and attendees present their work by either giving a talk or presenting a poster. Most resulting papers are reviewed, edited, and published in our yearly *Proceedings of the Eastern Snow Conference*. In recent years, the ESC meetings have included sessions on snow physics, winter survival of animals, snow and ice loads on structures, river ice, remote sensing of snow and ice, and glacier processes. Volumes of the *Proceedings* can be found in libraries throughout North America and Europe, and the papers are also available through the National Technical Information Service (NTIS) in the United States and CISTI in Canada.

* * * * *

Le Colloque sur la neige-région est (ESC) est une organisation américain-canadienne fondée dans les années '40 et dont les membres provenaient à l'origine surtout de l'est de l'Amérique-du-Nord. Actuellement, les membres, qu'ils soient chercheurs, techniciens en enneigement, ingénieurs, techniciens, professeurs, étudiants, et spécialistes des services d'exploitation et d'entretien, viennent non seulement d'Amérique-du-Nord, mais aussi du Royaume Uni, du Japon, et d'Allemagne. Le Colloque sur la neige-region ouest (WSC), aussi une organisation américain-canadienne, est l'homologue de l'ESC pour l'ouest nord-américain. Tous les cinq ans, l'ESC et la WSC organisent des réunions en commun.

Le Colloque sur la neige-region est un forum qui rassemble chercheurs et responsables des services d'exploitation pour discuter des travaux récents sur les problèmes scientifiques, opérationnels, ou autres dus à la neige et à la glace. Le site de cette réunion annuelle alterne entre les États Unis et le Canada. Les participants y présentent les résultats de leurs travaux par des communications orales ou au moyen d'affiches. Ces communications, une fois revues et éditées, sont publiées dans les *Annales de l'ESC*. Dans les années récentes, les réunions de l'ESC ont inclus des sessions sur la physique de la neige, la survie hivernale de la faune, les forces exercées par la neige et la glace sur les structures et les bâtiments, la glace de rivière, la télédétection de la neige et de la glace, et les processus glaciaires. Les *Annales de l'ESC* sont accessibles dans la plupart des bibliothèques scientifiques d'Amérique-du-Nord et d'Europe. Des copies d'articles peuvent être obtenues du National Technical Information Service (NTIS) aux États Unis et son équivalent au Canada, le CISTI.

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THE PRESIDENT'S PAGE

The annual meeting of the ESC, a venue for presenting new research results on the cryosphere in general and snow cover in particular, was highlighted by a strong showing from students. The 70th ESC meeting celebrated advances in cold regions research on the shores of Fairy Lake at the Huntsville Active Learning Center in adventurous Huntsville, ON, Canada.

I offer my whole-hearted thanks to all the presenters and attendees for making the trip to beautiful Huntsville, ON and contributing to the success of the 70th annual ESC meeting. As always, the success of the annual ESC meeting takes team-work and dedicated effort from executive members and the local arrangements crew. First of all, Alex Langlois (Vice President and Program Chair) coordinated an efficient program offering sponsors and presenters a convenient shared space for sharing ideas and networking. Alex also worked with the local arrangements committee and meeting facilitators to select a scenic and relaxing venue. This year's meeting included 29 oral presentations and 21 posters, with 22 contributions from students. There were so many students this year receiving the discounted registration rate that the executive had to pull from our rainy-day funds to pay the bills. Wow! We should all appreciate the dedicated oversight and innovative poster display solution from Miles Ecclestone and Kevin Kang and also the inspiring suggestions and excellent marketing work of Richard Kelly and Jim Buttle.

Student participation is an investment in the future growth of the ESC annual meeting including rewards for their work toward advancing cryospheric knowledge. Congratulations to Andreas Dietz, Earth Observation Center/DFD in Germany, winner of the Wiesnet Medal for best student paper and Nastaran Saberi, Waterloo University, for winning the David Hewitt Miller Award for best student poster. Regretably, there was no Campbell Scientific Prize awarded this year, but we fully expect a successful candidate next year.

Like all ESC meetings it's the highlights that we remember. I had the pleasure of: presenting the student awards, accepting subtle but deliberate signals from Miles to move things along, introducing Alex Langlois who presented this year's Sno-Foo Award and Ken Rancourt to reveal next year's new executive committee members. Although the banquet lacked an invited speaker, it did offer more time for attendees to enjoy local wine and delicious food, to interact with students and to talk shop with our sponsors. We also enjoyed a feast - a local BBQ provided by "3 Guys and a Stove". There was convenient accommodations from nearby hotels as well as the nearby Waterloo Summit Center for the Environment. After the last session, attendees enjoyed a fun and relaxing train ride on the Portage Flyer (below).



Alex Langlois, and yours truly continue to provide leadership in producing the ESC Proceedings, with help from members of the Executive. In addition, with strong motivation and volunteer time from executive membership, particularly the editorial work of Alex Langlois and the publishing/cartographic skills available to Miles Eccelstone and Andrew Klein, the entire back catalogue of Proceedings have now been scanned and formatted. Hopefully these will be available online at the ESC website (www.easternsnow.org) in the not-too distant-future.

We are especially indebted to our corporate sponsors who shared technological advances and offer financial support and institutional help. Campbell Scientific Canada, Geonor, Hoskin Scientific, and Bridgewater State University provided sponsorship for this year's meeting.

The ongoing success of the ESC relies on extensive behind-the-scenes efforts by our volunteer executives. Notable thanks are due to Miles Eccelstone and Derrill Cowing, our Canadian and American secretary treasurers. Miles and Derrill ensure the financial stability of the ESC, and always contribute significantly to the organization of the annual meeting. Also, we would be lost without the meticulous pre/post-executive meeting notes from Mary Jean Cowing. We continue to produce an annual special issue of *Hydrological Processes*--Mauri Pelto and Richard Kelly serve as Guest Editors for this widely read and respected publication with around 10 papers representing the ESC each year.

I'd like to invite you to the 2014 Eastern Snow Conference to be held on the campus of Appalachian State University in Boone, North Carolina in the heart of mountaineer country (technical program chair—Baker Perry, Geography, Appalachian State University). Please continue to check the ESC website for further developments.

Best regards and thank you for your continued support of the Eastern Snow Conference!

Rob Hellström

A handwritten signature in black ink that reads "Robert Hellstrom". The signature is written in a cursive style with a prominent initial 'R'.

President, 70th Eastern Snow Conference