Proceedings of the
FORTY-EIGHTH ANNUAL
EASTERN SNOW CONFERENCE
JUNE 5–7, 1991
GUELPH, ONTARIO
FOREWORD

The 48th annual Eastern Snow Conference (ESC) was held in Guelph, Ontario, on June 6th and 7th, 1991. The program included oral and poster presentations, and displays of scientific equipment. For the first time, all of the papers at the conference were reviewed, and the revised papers appear in these proceedings. The officers of the ESC hope that the newly instituted review process and Honor Paper Award will assist the authors in improving their papers, upgrade the quality of the proceedings and make the ESC an even more valuable forum for discussion of operational, applied, and scientific issues related to snow and ice.

In order to permit the timely reporting of recent results, we collected draft manuscripts at the meeting. The chairman of each session coordinated the review of papers in his/her session. If the chairman was also an author of a paper in the session, the responsibility for review of that paper was shifted to another chairman. At least two reviews were obtained for each paper and returned to the authors. Final camera-ready manuscripts were submitted by the authors in early September. Comments received from the authors concerning the review process were again almost entirely favorable. The clear majority thought that their final manuscripts represented a significant improvement over the draft, and we agree.

In addition to the review process, the 1991 proceedings include the designation of an Honor Paper Award by the ESC. During the review process the referees nominated papers that they considered worthy of consideration for this award. The criteria that were included in this judgment included:

1. Clarity of the written presentation,
2. Originality of the contribution, and
3. Importance of the work in practice or in basic understanding of snow- and ice-related processes.

Three papers received unanimous nominations by the reviewers for consideration as the 1991 Honor Paper. The final camera-ready version of each of these papers was reviewed by a 5-person panel having a broad range of backgrounds and interests. The nominated papers were all of high quality, as indicated in the point totals assigned by the reviewers. The 1991 Honor Paper Award was presented to A. Hewitt, J.H. Cragin and S.C. Colbeck for their paper entitled “Effects of crystal metamorphosis on the elution of chemical species from snow.”

Publication of this year’s proceedings was accomplished with the assistance of the U.S. Army Cold Regions Research and Engineering Laboratory (Technical Communication Branch, Information Management Division). The editors especially thank Sandra Smith for her exceptional effort in the final production of this document.

The editors have received several inquiries from authors concerning journal publication of papers presented at the ESC and published in these proceedings. We are pleased by this development and consider it a tribute to the quality that is being achieved by the ESC. The ESC is a valuable forum for discussion of recent work, and the session chairs, reviewers and authors have cooperated with the editors to assure the timely publication of the proceedings. We request that for journal publication authors expand the reports of their work published in these proceedings. A final journal paper can discuss the same subject and include the parts of the ESC version that remain relevant, but the contents should not be identical. An acknowledgment of the ESC in the final work would be much appreciated and effective for spreading the word in a very positive way about the Conference.
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 Secretary. The annual meeting of the Eastern Snow Conference is co-sponsored by the American Geophysical Union and the American Water Resources Association. Publication of these proceedings is made possible in part by Corporate Memberships in the Conference held by:

Hydro Québec
75 Boulevard René Lévesque
Montréal, Québec
CANADA H2Z 1A4

Province of New Brunswick
Department of the Environment—Water Resources
P.O. Box 6000
Fredericton, New Brunswick
CANADA E3B 5H1

Ontario Hydro
700 University Ave.
Toronto, Ontario
CANADA M5G 1X6

Niagara Mohawk Power Corp.
300 Erie Blvd. West
Syracuse, N.Y. 13202
U.S.A.

We look forward to another outstanding meeting in Oswego, June 1992.

Michael Ferrick
Editor

Timothy Pangburn
Associate Editor
TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOREWORD</td>
<td>iii</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td>v</td>
</tr>
<tr>
<td>STATEMENT OF PURPOSE</td>
<td>viii</td>
</tr>
<tr>
<td>EASTERN SNOW CONFERENCE OFFICERS</td>
<td>x</td>
</tr>
<tr>
<td>PRESIDENT'S PAGE</td>
<td>xi</td>
</tr>
</tbody>
</table>

SESSION PAPERS

**Honor Paper Award**—Effects of Crystal Metamorphosis on the Elution of Chemical Species from Snow

_A.D. Hewitt, J.H. Cragin and S.C. Colbeck_ ........................................... 1

**Student Paper Prize**—An Improved Method of Predicting Snowpack Water Equivalent

_D. Samelson_ ................................................................................................. 11

Areal Snow Accumulation-Ablation Model (ASAAM): Experience of Real-Time Use in Southwestern Ontario

_H.O. Schroeter, D.K. Boyd and H.R. Whiteley_ ........................................ 25

Terrain Classification of Snow-Covered Watersheds

_K. Elder, R.E. Davis and R.C. Bales_ ..................................................... 39

Snow Depth/Area Relationships for Various Landscape Units in Southwestern Ontario

_M.B. Burkard, H.O. Schroeter, J.R. Donald and H.R. Whiteley_ ................ 51


_D.C. Norton_ ................................................................................................. 67

Water, Energy, and Biogeochemical Budgets at Sleepers River, Danville, Vermont: A Research Plan

_J.B. Shatney, E.T. Sandquist and J.C. Denner_ .................................... 81

Ionic Mass Balance for a Small High Arctic Wetland Basin During Spring Snowmelt

_K.E. Fraser, J.M. Buttle, W.P. Adams and M.A. Ecclestone_ ................... 91

SNOQUAL, A Snow-Meltwater Quality Model: A Study of Model Variants

_H.G. Jones, J. Stein and W. Sochanski_ ............................................... 105

Verification of Statistical Forecast Guidance for 1-Day and 2-Day Mesoscale Forecasts of Lake-Effect Snow off Lake Huron, Georgian Bay

_W.R. Burrows_ ............................................................................................ 119

Snow Accumulation and Climate Over the Grand Lake Catchment, Newfoundland

_C.E. Banfield_ ............................................................................................ 133
Snow Depth Estimates for Shallow Snowpacks From GOES Visible Imagery
J.R. Donald, E.D. Smailis, F. Segleniks and N. Kouwan .................................................. 149

Microwave Propagation Over a Changing Snowcover
L. Peck ................................................................................................................................. 163

Modelling the Transport and Sublimation of Blowing Snow on the Prairies
J.W. Pomeroy, D.M. Gray and P.G. Landine .................................................................... 175

Multidimensional Observation of Snow Temperature on Windy Days
M.R. Albert and W.R. McGilvary ...................................................................................... 189

Ship Superstructure Icing Climatology of Coastal Eastern North America
C.C. Ryerson ...................................................................................................................... 201

Snow as an Expedient Adsorbent for Hazardous Waste Spills
C.J. Martel and B.M. Nadeau ........................................................................................... 213

High Latitude, West Coast Mountaintop Icing
K.J. Claffey and C.C. Ryerson .......................................................................................... 221

Aeration Systems and Winter Streamflow Measurements at Sleepers River, Danville, Vermont
J.C. Denner and J.B. Shanley ............................................................................................ 233

Investigation of Temperature Variation Over Snow-Covered Ground
A. Hogan and M. Ferrick ...................................................................................................... 245

Prediction of Snow Loading on large Snow Roofs
S.L. Gamble, W.W. Kochanski and P.A. Irwin .................................................................. 255

POSTER PAPERS

A Computer Tutorial for Great Lakes Ice Cover Climatology
R.A. Assel .......................................................................................................................... 267

Extinction Coefficient Measurements in Rain and Snow Using a Forward Scatter Meter
D.L. Hutt and J. Oman ......................................................................................................... 273

High-Wind Snow Collector for Chemical Analysis
J.W. Govoni and D.A. Meese ............................................................................................. 281

Snow, Ice and Frozen Ground Observations in a Pond/Marsh Wetland
R.A. Melloh and C.H. Racine ........................................................................................... 285

Snow Infiltration in Fresh Air Intakes “What Can be Done”
M.J. Soligo and G.D. Schuyler ......................................................................................... 293

Precise Water Temperature Measurement at Remote Field Sites
C. Clark, S. Daly and J. Rand .............................................................................................. 301

Arctic Snowfences—A Big Solution For a Big Problem
C.J. Williams and B.F. Waechter ....................................................................................... 307
The Eastern Snow Conference (ESC) is a joint U.S./Canadian organization which was founded in the 1940’s. It is an association of people interested in research and applied aspects of the study of ice in all its forms, especially snow. The principal activities of the ESC are the organization of an annual meeting, in the U.S. or Canada in alternate years, and the production of the annual Proceedings of the Eastern Snow Conference, which now form more than forty volumes deposited in libraries throughout North America and Europe. The annual meetings are sometimes held in major cities such as Washington, Montreal, Toronto or Boston and sometimes in smaller cities such as Peterborough, Oswego, Portland or Fredericton.

The members of the ESC are a very diverse and, over the years, fluctuating, group. They include professional snow surveyors, engineers and technologists (of various stripes), professors and students, hydrologists and biologists, people responsible for keeping roads clear of snow and rivers free of ice, and others interested in snow and agriculture. The members are drawn from all parts of eastern North America, they live and work in places which extend from Maryland to the high Arctic. The line between the territory of the ESC and its counterpart in the other half of the continent, the equally venerable Western Snow Conference, is not a precise one. Residents of the Mid-west and of the Prairie provinces seem to join one or the other organization on the basis of personal whim such as a preference for Reno, Nevada, over Bangor, Maine, as a desirable meeting place.

In recent years, the annual ESC meetings have included sessions on snow and small mammals, snow and buildings, river ice, permafrost, remote sensing of snow and ice, biology of sea ice, snow and ice on lakes, measuring snow and ice, hydroelectricity and snow and ice, glaciers, icebergs, snow and farming, etc.

---

Eastern Snow Conference est une organisation internationale canado-américaine fondée dans les années ’40. Elle regroupe des gens qui ont des intérêts communs dans l’étude théorique et pratique de la glace sous toutes ses formes, en particulier sous la forme de neige. Eastern Snow Conference a comme activités principales d’organiser sa réunion annuelle en alternant le site du Canada aux États-Unis, d’en produire les comptes-rendus qui se montent maintenant à plus de quarante volumes que l’on peut trouver dans les bibliothèques de l’Amérique du Nord et d’Europe. La réunion annuelle peut se tenir tout aussi bien dans des villes importantes comme Washington, Montréal, Toronto ou Boston comme dans des plus petites comme Peterborough, Oswego, Portland ou Frédericton.


Dans les dernières années, aux réunions annuelles de l’Eastern Snow Conference on a tenu des sessions sur la neige et les petits mammifères, la neige et le bâtiment, la glace de rivières, le pergélisol, la télédétection de la neige et de la glace, la biologie de la glace marine, la neige et la glace lacustres, la mesure de la glace et de la neige, l’hydroélectricité et la glace et la neige, les glaciers, les icebergs, la neige et l’agriculture, etc.
EASTERN SNOW CONFERENCE OFFICERS
1990–1991

PRESIDENT
Nabil Elhadi
Department of the Environment—Water Resources
P.O. Box 6000
Fredericton, New Brunswick E3B 5H1

VICE-PRESIDENT
Timothy Pangburn
U.S. Army—CRREL
72 Lyme Road
Hanover, New Hampshire 03755-1290

PAST-PRESIDENT
H. Gerald Jones
INRS-ÉAU
Université du Québec
Ste. Foy, Quebec G1V 4C7

SECRETARY/TREASURER
John Metcalfe
161 London Road
Newmarket, Ontario L3Y 7A7

ASSISTANT SECRETARY
Donald Dunlap
12 Seaman Street
New Brunswick, New Jersey 08901

EDITORS
Michael Ferrick and Timothy Pangburn
U.S. Army—CRREL
72 Lyme Road
Hanover, New Hampshire 03755-1290

STEERING COMMITTEE
Derrill Cowing
Terry Prowse
Colin Taylor

RESEARCH COMMITTEE
Richard Fontaine, Chairman
Brian Day
Grady Moore
Robert E. Davis
Michael Demuth

EQUIPMENT COMMITTEE
Stan Zeccolo, Chairman
John Govoni
James DeVenney

SNOW SURVEY COMMITTEE
Robert Fox
Paul Lamb
Thomas Brewer

LOCAL ARRANGEMENTS COMMITTEE
Hugh Whiteley

CORPORATE MEMBERS
Hydro Québec, New Brunswick Department of Environment, Ontario Hydro, and
Niagara Mohawk Power Corporation
THE PRESIDENT’S PAGE

The 48th Eastern Snow Conference in Guelph, Ontario, was another successful event as a result of the contribution of many individuals; and particularly the authors of papers and the members who made the conference very stimulating.

This has been our second year with the Honor Paper Award Program and we are satisfied with the result. This program has created a participative attitude among the members of the Eastern Snow Conference, and the peer review and constructive comments have resulted in a better publication for the benefit of us all.

We have been planning much in advance for the 50th Anniversary event of the Eastern Snow Conference. A joint meeting with the Western Snow Conference is being organized. An opportunity to meet the members of the Western Snow Conference and an occasion for diverse technical sessions will be of interest to all of us. The 50th anniversary meeting will be held in beautiful Quebec City, and we are hoping for a great attendance.

The Research Committee made an outstanding effort in reaching an ever increasing audience for student paper presentations for the Student Paper Competition as well as for papers for the technical and poster sessions. The winner of the Student Paper Competition this year was Daniel Samelson of Cornell University and the title of his paper was “An Improved Method of Predicting Snowpack Water Equivalent.”

The Snow Survey Committee distributed the Snow Survey Schedule and the schedule of Landsat satellite overpasses to the Regional Offices. The schedule is widely distributed in order to ensure the consistency and the continuation of snow data collection. The Committee is working on the compilation of material necessary for the production of a “Snow Video.” This video will be used as an educational tool on snow surveying, field measurements and equipment.

The Equipment Committee is busy developing a process which will be utilized for annual articles on specific types of equipment that will be included in the proceedings of the Eastern Snow Conference.

Finally, many thanks to the members of the Executive, the committee chairmen and members as well as the local arrangement committee. It is due to their hard work and dedication that the conference was so successful.

The 49th Eastern Snow Conference will be held in Oswego, New York, which marks our 20th anniversary visit to Oswego. See you all there.

Nabil Elhadi
President
Eastern Snow Conference