



**Proceedings of the
FIFTY-THIRD ANNUAL**

EASTERN SNOW CONFERENCE

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Proceedings of the Eastern Snow Conference

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FOREWORD

This proceedings contains papers presented at the 53rd annual Eastern Snow Conference (ESC) in Williamsburg, Virginia, on May 2 and 3, 1996. The ESC 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. Topics typically discussed include the physics of snow and ice, snow removal, meteorological forecasting, river ice control, hydrochemical response of snow melt, remote sensing of snow and ice, and winter ecology. At the conference both oral and poster papers are presented, as well as displays of scientific equipment.

The theme of the conference this year was "Remote Sensing of Snow and Ice." For this proceedings, the papers are arranged into four topic areas: 1) Remote Sensing of Snow Covers, 2) Snow Parameter Signatures for Remote Sensing, 3) Hydrology and Chemistry of Snow and Ice, and 4) Snow Effects and Observations. All of the papers received at least two reviews. The editors read each paper twice, first to ensure that the reviews were thoughtful and constructive, and the second time to check that the authors appropriately considered review comments in the final papers.

The ESC has a partnership with *Hydrological Processes*, and some of the papers in this volume will also be published in the December 1996 issue of the journal. Authors who want their papers considered for publication in *Hydrological Processes* must submit their papers before the conference to allow for the additional journal review, revision, and referee process.

We thank members of the Library and Technical Publishing Branch, Technical Resources Center, U.S. Army Cold Regions Research and Engineering Laboratory. Over the years this group has contributed considerable time to the proceedings and enhanced their quality. The editors especially thank Edmund Wright and Sandra Smith for their efforts in the final production of this document.

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 cosponsored by the American Geophysical Union, the American Water Resources Association, and the State University of New York, Oswego Campus. Publication of these proceedings is made possible in part by Corporate Memberships in the Conference held by:

* Hydro Quebec, 75 Boulevard René Lévesque, Montréal, Québec, Canada H2Z 1A4

* Department of the Environment-Water Resources, Province of New Brunswick, P.O. Box 6000, Fredericton, New Brunswick, Canada E3B 5H1

* Ontario Hydro, 700 University Ave., Toronto, Ontario, Canada M5G 1X6

We look forward to the 54th meeting of the Eastern Snow Conference, which will be a joint meeting with the Western Snow Conference and the Canadian Geophysical Union-Hydrology Section, at Banff, Alberta, Canada, on May 4-9, 1997.

Mary R. Albert and Susan Taylor
Editors, Eastern Snow Conference

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The Eastern Snow Conference (ESC) is a joint Canadian/U.S. 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, as well as the United Kingdom, Japan, and Germany. There is a western counterpart to the ESC, the Western Snow Conference (WSC), also a joint Canadian/U.S. 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. All 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.

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Le Colloque sur la neige-région est (ESC) est une organisation américano-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, ou 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-région ouest (WSC), aussi une organisation américano-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-région 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 Etats 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 Etats Unis et son équivalent au Canada, le CISTI.

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Don Dunlap, Art Eschner, Hilda Snelling, Bob Sykes, Don Wiesnet

THE CONSTITUTION AND BYLAWS OF THE EASTERN SNOW CONFERENCE

CONSTITUTION

ARTICLE I. NAME AND LOCATION

Section 1. The name of this organization shall be the "Eastern Snow Conference." The area to be included in this organization shall be eastern North America.

ARTICLE II. OBJECTIVES

Section 1. The objectives of the organization are:

- a. To discover and analyze the laws pertaining to the formation of the snow mantle and the behavior and disposition of this mantle.
- b. To report on the collection, dissemination, and analysis of data relating to snow and ice.
- c. To encourage dialogue among the various persons and organizations that deal with snow and ice and the effects of the winter season.

ARTICLE III. MEMBERSHIP

Section 1. Membership shall be open to all individuals and organizations interested in the work and objectives of the Conference. Application for membership shall not be required. The membership roll shall be made up of all individuals and organizations who are interested in the work and objectives of the Conference, and who have paid a membership fee.

Section 2. Any member in attendance at a meeting may vote.

Section 3. Any member whose name appears on the membership roll may hold office.

ARTICLE IV. OFFICERS

Section 1. The officers of the conference shall consist of a President, Vice-President, Secretary-Treasurer, Proceedings Editor(s) and Steering Committee of four members. These officers, the Steering Committee, and chairs of all committees make up the Executive Committee. The immediate past President and the members of other standing committees, including the Local Arrangements Committee, shall be invited to join the Executive Committee. A total of at least eight of these members shall constitute the Executive Committee in which shall be vested the general government of the organization. The Executive Committee selects life members of the Conference.

Section 2. All officers, including Steering Committee members and replacements, shall be nominated by a nominating committee appointed by the President at the Annual Meeting. Nominations for any position may be made from the floor at the Annual Meeting. The officers shall be elected in the manner determined by the President to be the most suitable at the Annual Meeting. A show of hands is preferable.

Section 3. The terms of office of all officers shall begin at the close of the Annual Meeting at which they are elected and shall continue through the following Annual Meeting or until their successors are duly chosen.

Section 4. Any vacancy shall be filled by action of the remaining members of the Executive Committee.

ARTICLE V. MEMBERSHIP FEES AND CHARGES

Section 1. Membership fees shall be established by the Executive Committee and changes in fees shall be ratified by the members at the next Annual Meeting.

Section 2. Fees and charges for meetings, publications and the like shall be established by the Executive Committee.

ARTICLE VI. MEETINGS

Section 1. The meetings of the organization shall consist of the Annual Meeting, the date for which shall be determined by the Executive Committee and any other meeting that may be called by the Executive Committee.

Section 2. Ten members personally present at the Annual Meeting shall constitute a quorum for the transaction of business.

ARTICLE VII. AMENDMENTS

Section 1. The constitution may be amended at any Annual Meeting by an affirmative vote of two-thirds of the members voting, provided notice of proposed amendment was distributed to the members at least three weeks prior to the Annual Meeting.

BYLAWS

ARTICLE I. DUTIES OF OFFICERS

Section 1. The President shall have general supervision of the affairs of the organization and shall preside at all meetings of the organization and of the Executive Committee.

Duties: The President shall prepare an agenda for the Executive Committee and shall record the actions of the Executive Committee. The President shall prepare a report on actions during his/her presidency, which shall be published in the Proceedings. This report shall include the roster of the Officers, Committee Chairs and Members, and Conference Life Members.

The President shall coordinate arrangements for the Annual Meeting with the Local Arrangements Chair and develop an agenda for Executive meeting. Each agenda shall include a Secretary-Treasurer Report, Research Committee Report, Technical Committee Report, including Snow Survey Scheduling, Proceedings Editor Report, Local Arrangements Report, Details of Upcoming Annual Meeting, and Location of Subsequent Annual Meeting.

The President shall preside at the Annual Meeting, appoint a nominating committee of at least three members, and host the Annual Banquet. The President shall appoint members to fill any vacancies of the Executive Committee between meetings.

Section 2. The Vice-President shall, in the absence of the President or in the event of a vacancy in that office, discharge the duties of that office.

Duties: The Vice-President shall prepare a "Call for Papers" in French and English outlining the topics for the Annual Meeting. Thereafter, he/she shall receive abstracts from authors and establish a procedure in consultation with the President and Proceedings Editor for selecting papers to be presented at the Annual Meeting, notify each author of acceptance, or rejection, and provide details regarding their oral or poster presentation.

The Vice-President shall also prepare a typed list of titles and authors for the Secretary-Treasurer, and appoint Chairs for Oral and Poster Sessions. Members of the Executive Committee are to be the primary candidates.

The Vice-President shall prepare a sufficient quantity of programs for distribution by the Secretary-Treasurer one month prior to the Annual Meeting.

Section 3. The Secretary-Treasurer shall be responsible for all financial records of the organization and shall submit to the members a report on the annual finances of the Conference at the Annual Meeting. An Assistant Secretary may be delegated, who may act in lieu of the Secretary.

Duties: The Secretary-Treasurer shall collect and record fees received, record and balance receipts and expenditures, prepare and present a financial statement biannually, distribute Annual Proceedings to paid members and five copies to each corporate members, distribute and invoice Proceedings to libraries and other standing orders, distribute and invoice requests for current and back issues of Annual Proceedings, maintain an up-to-date membership list and mailing list, and mail notices of the annual meeting.

Section 4. The Proceedings Editor shall coordinate review of papers and publication of the Proceedings of the Annual Meeting.

Duties: The Proceedings Editor shall report the year's events to membership, explain review procedures, coordinate review of all manuscripts with the session chairs, and collect reviewed papers and comments from the session chairs within five weeks following the Annual Meeting. These shall be forwarded immediately to the authors together with instructions to authors for final manuscript submittal. The final manuscripts shall be collected from the authors by September 15. Final editorial review shall be provided to ensure that the review comments are addressed or explained successfully and that the instructions to authors have been followed. The Proceedings Editor shall notify Chair of the Research Committee and Secretary-Treasurer when final versions of student paper winner and runner-up are received.

ARTICLE II. COMMITTEES

Section 1. Duties of Eastern Snow Conference committees are as follows:

The Steering Committee shall participate in Executive meetings as requested by the President, stand ready to assist ESC officers with special items of business, serve as session chairs at the Annual Meeting, and coordinate reviews for papers in session. In future years members serve as Vice President, President, and Past President, periodically review the Constitution and Bylaws, and suggest changes when appropriate.

The Research Committee shall coordinate Student Paper competition, solicit entries, handle reviews and selection of winner and runner-up, update mailing lists for poster advertising Student Paper competition, keep track of Weisnet Medals and engraving for each winner, notify the Secretary-Treasurer of status of the winner so that prize can be awarded, and update and periodically publish a bibliography of all Eastern Snow Conference papers.

The Technical Committee shall develop a snow survey schedule for inclusion in Conference mailings to interested parties, maintain and update Snow Survey mailing list, actively encourage (through letters, etc.) commercial exhibits at Annual Meeting, maintain and update a list of commercial vendors, maintain, update and coordinate the Technical and Equipment Bulletin Board, develop and maintain a catalog of snow and ice cover data sources and techniques for measuring snow and ice in the field and with remote sensing. The Chair of the Technical Committee shall coordinate the Sno-Foo Award.

Section 2. The Executive Committee shall appoint other committees as appropriate.

ARTICLE III. AMENDMENTS

Section 1. These bylaws may be amended at any Annual Meeting by an affirmative vote of two-thirds of the members present and voting, provided that notice of the proposed amendments was distributed to the members at least three weeks prior to the Annual Meeting.

This document was prepared by the Steering Committee, which was appointed by the Executive Committee subsequent to the Annual Meeting in 1994. It was revised following the receipt of comments from many members, and was approved at the Annual Meeting in 1996.

THE PRESIDENT'S PAGE

The 53rd Eastern Snow Conference at the Fort Magruder Inn in Williamsburg, Virginia, was by all measures another very successful meeting. The elegant and historical setting of the inn was complemented by excellent conference facilities. The walking tour of colonial Williamsburg in delightful weather and the colonial banquet with ballads and songs firmly established the historical flavor of the meeting. Luncheon speaker Pat Michaels, State Climatologist of Virginia, provided a link between the colonial period and the present by comparing winter temperatures and major snowfalls in Virginia over the historical record.

The ESC continues to provide an international forum for relaxed and cordial discussion of problems relating to snow, ice and the winter season. The Conference is unique because of the active involvement of Life Members, Past Presidents and other regulars, mixing with that of students and new members. The capability to annually organize a lively meeting and publish reviewed proceedings and a special issue of *Hydrological Processes* depends on the dedication of many talented individuals. Key among these are the members of the ESC Executive, and I want to thank them all for their continued efforts. I strongly encourage all members to consider service on the Executive, and to make your interest known to any current member. The continued strength of the ESC depends on a steady infusion of new people and their energy onto the Executive.

The local arrangements committee provides the foundation for a smooth and enjoyable conference by handling details, and adding elements to the meeting so attendees will come away with an appreciation of the special aspects of the location, in this case colonial Virginia. Local arrangements in Williamsburg were skillfully managed by Dorothy Hall and Jim Foster. Mike Demuth developed the technical program around the themes of remote sensing of snow and ice, continental-scale snow cover assessment, snow and ice chemistry and ecology, and general sessions. He arranged for a keynote address on the winter 1996 flood disaster in the mid-Atlantic states, and an overview of an upcoming book on snow ecology. Bert Davis, with help from many contributors, prepared an updated Constitution and Bylaws for the organization that were approved by the membership pending minor amendments. The final version of this document is published in these Proceedings. Editors Mary Albert and Susan Taylor have again produced timely Conference publications, and Secretary-Treasurers Austin Hogan and Miles Ecclestone have again managed the mailings, registration and cash flow of the Conference. Finally, I wish to thank the authors, reviewers, session chairs and attendees for their contributions to the success of the meeting.

Several awards were presented at our 53rd meeting. The research committee reviewed the student papers, and presented the Wiesnet medal recognizing Suzanne Hartley's outstanding paper, "Atlantic Sea-Surface Temperatures and New England Snowfall." Daniel Martin and Derek Mueller also received student awards. The Conference benefited greatly from several excellent oral and poster presentations. The session chairs and Executive voted on the outstanding presentation awards, recognizing Bill Wergin for his oral presentation of "The Structure and Metamorphism of Snow Crystals as Revealed by Low Temperature Scanning Electron Microscopy," Chris Derkson for his poster presentation of "A technique for the Quantitative Spatial Analysis of Sea Ice Melt Features Using Low-level Aerial Photographs," and Mike Demuth for his poster presentation of "The Significance of Glacier Contributions to Reservoirs on the Eastern Slope Montane Eco-zone, Canadian Rocky Mountains." Life Membership is the most significant honor bestowed by the ESC Executive. Members achieve this designation only when many years of significant work in a field related to snow and ice are combined with long and active membership in the Conference. I had the privilege to award the 5th Life Membership to Art Eschner in recognition of his many contributions to snow and ice research and teaching, and to the ESC.

Plans continue to develop for our 54th meeting, May 4-9, 1997, at Banff, Alberta. It will be the second in a series of joint meetings with the Western Snow Conference, and in addition, we will be joined by the Canadian Geophysical Union's Hydrology Section. I look forward to this special meeting, and hope that you will all make plans to attend.

Michael Ferrick
53rd President
Eastern Snow Conference