



60th Annual Meeting

Western Snow Conference

April 14-16, 1992

**Snow King Resort
Jackson Hole,
Wyoming**

PROCEEDINGS
OF THE
WESTERN SNOW CONFERENCE

Jackson, Wyoming

April 14-16 1992

SIXTIETH ANNUAL MEETING

Dr. Albert Rango (General Chairman)
USDA-ARS Hydrology Laboratory
Bldg. 265, Room 205, BARC-East
10300 Baltimore Avenue
Beltsville, MD 20705-2350

James K. Marron (Secretary)
P.O. Box 2646
Portland, OR 97208-2646

Barbara Sarantitis (Treasurer)
P.O. Box 2646
Portland, OR 97208-2646

Program Committee

Harold Stepphun, Chairperson
Gerald Beard
Keith Cooley
Phyllis Snow
Peter Palmer

Editorial Committee

Charles Troendle, Chairperson
Bernard Shafer, Editor
James K. Marron

Printed by

Colorado State University
Fort Collins, Colorado

For Sale by the Western Snow Conference - \$25.00

Order from: Gary Hester
P.O. Box 2646
Portland, OR 97208-2646

FOREWORD

This publication reports the available papers and formal discussions presented at the Sixtieth Annual Meeting of the Western Snow Conference. On this occasion the Conference convened at the Snow King Resort in Jackson, Wyoming on April 14-16, 1992. It is hoped that the various reports presented in these Proceedings will be of value to those concerned with snow and water in their several forms and many important uses and will be an inspiration to vigorously continue research, development, and application in this field of science.

Correspondence regarding these Proceedings or other Western Snow Conference matters should be addressed to Neil Berg, Chairperson, P.O. Box 2646, Portland, Oregon 97208-2646.

The publication of this report is made possible through dues and registration fees from individual members and the following organizations who hold corporate memberships or have purchased copies of former Proceedings.

Academic Book Center, Inc., 5600 N.E. Hassalo Street, Portland, OR 97213-3640
Acres International Ltd., P. O. Box 1001, Niagara Falls, ON, Canada L2E 6W1
Adolph Coors Co., Mail RR 856, Golden, CO 80401
Alberta Energy & Nat. Res. Lib., 9915 - 108 Street, Edmonton, AB, Canada T5K 2C9
Alberta Environment, 9820 - 106 St., 14th, Edmonton, AB, Canada T5K 2J6
Alberta For., Lands, and Wildlife, Box 3310, Postal Station, Calgary, AB, Canada T2M 4L8
ALCAN International Limitee, C.P. 1250/1955, boul. Mellon, Jonquiere, QU, Canada G7S 4KB
ANENA, 15 rue Ernest Calvat, Grenoble 38000 FRANCE
Atmospheric Env. Service, 4905 Dufferin St., Downsview, ON, Canada M3H 5T4
Atmos. Environ. Ser., 4999 - 98 Avenue, Edmonton, AB, Canada T6B 2X3
BIBLIOTECA CENTRAL, Laval 1554 - 2 piso, 1325 Buenos Aires, ARGENTINA
British Embassy, 3100 Massachusetts Ave. NW, Rm 645, Washington DC 20008
California State Library, P. O. Box 2037, Sacramento, CA 98509
California State U. Northridge, 18111 Nordhoff St., Northridge, CA 91330
Campbell Scientific Canada Corp., 9525 41 Avenue, Edmonton, AB, Canada T6E 5X7
CENPA-IM-S-L Library, BLDG. 21-700, RM. 143, Anchorage, AK 99506-0898
Center for Computer Science, 1990 M Street, NW, Suite 680, Washington DC 20036
City of Seattle, 1015 Third Ave., Seattle, WA 98104
Civil Engineering Res. Inst., Hokkaido Development Bureau, Hiragishi, Sap Hokkaido, JAPAN 060
College of Envir. Sci. & For., State University of New York, Syracuse, NY 13210
Curran Associates, Inv., Route 23, PO Box 620, Claverack, NY 12513
Department of Water & Power, P. O. Box 111, Rm. 1466, Los Angeles, CA 90051
Dept. of Public Utilities, P. O. Box 11007, Tacoma, WA 98411
Dept. of Water Resources, P. O. Box 388, Sacramento, CA 95814
Director, WDC-BI, 6, Korolyov Str., Obninsk, Kaluga Reg. 249020, U.S.S.R.
Div. of Hydrology, Rm 2A20 Eng., University of Saskatchewan, Saskatoon, SA, Canada S7N 0W0
Eastern Snow Conference, 4905 Dufferin Street, Downsview, ON, Canada M3H 5T4
Engineering Societies Library, 345 East 47th St., New York, NY 10017
Environmental Canada, Ottawa, ON, Canada K1A 0H3
Geographisches Institut ETH, Winterthurerstr. 190, Zurich, CH-8057 SWITZERLAND
Green Library, Stanford University, Stanford, CA 94305
HIDRONOR, H. YRIGOYEN 379, 8324-Cipolletti (R.N.), ARGENTINA
Humboldt State University, Arcata, CA 95521
Iidabashi High Town 306, 15 Shimomiyabicho, Shinjuku-ku, TOKYO 162, JAPAN
Institute for Scientific Information, 3501 Market Street, Philadelphia, PA 19104
INTERDOCK Corp., 173 Halstead Avenue, P.O. Box 326, Harrison, NY 10528
Kawahara Bldg., Nishi 7-chome 1-jo, Chuo-ku, Minami, Sapporo 060, JAPAN
Lib. & Info. Ser. NOAA, 6009 Executive Blvd., Rockville, MD 20852
Washington Depart. of Nat. Res., MS PY12 - Div. of Geology & Earth Res., Olympia, WA 98504
Linda Hall Library, 5109 Cherry St., Kansas City, MO, 64110
Marriott Library, University of Utah, Salt Lake City, UT 84112
MARTINUS NIJHOFF International, P.O. Box 269, 2501 AX, The Hague, NETHERLANDS
McMaster University Library, Hamilton, ON, Canada L8S 4L6
Ministry of Defence, Res. & Devel. Organ. Hdq., Snow & Avalanche Study, C/O 56 APO, INDIA
Ministry of Forests & Lands, 1450 Government Street, Victoria, BC, Canada V8W 3E7
MONENCO Consultants Limited, P. O. Box 6088, Station A, Montreal, ON, Canada H3C 3Z8

National Cent. for Atmos. Res., P. O. Box 3000, Boulder, CO 80307
National Hydrology Res. Inst., 11 Innovation Blvd., Saskatoon, SK, Canada S7N 3H5
National Weather Service, 220 N W 8th Ave., Portland, OR 97209
National Weather Service, 819 Taylor Street, Room 10A26, Forth Worth, TX 76102
National Weather Service, P.O. Box 11188, Federal Bldg., Salt Lake City, UT 84147
National Weather Service, Reno Municipal Airport, 601 S. Rock Blvd., Reno, NV 89502
National Weather Service, 8060 13th Street, Silver Springs, MD 20910
NNR Air Cargo Service, Hook Creek Blvd & 145 Avenue, Valley Stream, NY 11581
North American Weather Cons., 3761 South 700 East, Suite B, Salt Lake City, UT 84106-1155
Northern Affairs Program, 200 Range Road, Whitehorse, YT, Canada Y1A 3B1
Northern Colorado Water Cons. Dis., P. O. Box 679, Loveland, CO 80537
Oregon State University, Kerr Library 121, Corvallis, OR 97331-4503
Pacific Power and Light Co., 920 S.W. Sixth Ave., Portland, OR 97204
PUD of Grant County, P. O. Box 878, Ephrata, WA 98823
Queen's University Library, Kingston, ON, Canada K7L 5C4
Rudolf Muller International, P. O. Box 9016, Amsterdam, HOLLAND
Sacramento Mun. Util. Dist., P. O. Box 15830, Sacramento, CA 95813
Salt River Valley Water User's, P. O. Box 52025, Phoenix, AZ 85072-2025
Scott Polar Research Institute, Cambridge, ENGLAND
Southern Cal. Edison Company, 2244 Walnut Grove, P.O. Box 800, Room 186, Rosemead, CA 91770
State Engineer, Herschler Bldg., 4th Floor, Cheyenne, WY 82001
State Engineers Office, State Capitol, Bataan Memorial Bldg. Rm 101, Santa Fe, NM 87503
Tabler & Associates, P.O. Box 483, Niwot, CO 80544
Technischen Universitat Graz, TechnikerstraBe 4, 8010 Graz, AUSTRIA
The Institute of Low Temp. Sci., Hokaido University, Sapporo, JAPAN 062
The Montana Power Company, 40 E. Broadway, Butte, MT 59701
Universitaets - Bibliothek, Zugang 11a PrinzenstraBe 1, 34 Goettingen, WEST GERMANY
Universitetsbokhandel, Postboks 84, Blindern, 0314 Oslo, 3 NORWAY
University of Alberta, University Library, Edmonton, AB, Canada T6G 2J8
University of Alberta, Edmonton, AB, Canada T6G 2E9
University of Arizona, Tucson, AZ 85717
University of British Columbia, 2206 East Mall, Vancouver, BC, Canada V6T 1Z8
University of California, Berkeley, CA 94720
University of California, Davis, CA 95616-5292
University of California, Santa Barbara, CA 93106
University of California, 410 O'Brien Hall, Berkeley, CA 94720
University of Canterbury, LIB/Private Bag, Christchurch 1, NEW ZEALAND
University of Colorado, Campus Box 450, Boulder, CO 80309
University of Colorado, Boulder CO 80302
University of Colorado, CIRES, Campus Box 449, Boulder, CO 80309
University of Guelph, Guelph, ON, Canada N1G 2W1
University of Michigan, 3140 Natural Science Bldg., Ann Arbor, MI 48109
University of Minnesota, 1984 Buford Ave., St. Paul, MN 55108
University of Minnesota Libraris/1ACE8831, 309-19th Avenue South, Minneapolis, MN 55455-0414
University of Montana, Missoula, MT 59812
University of Nevada, Reno, NV 89507
University of Saskatchewan, Saskatoon, SK, Canada S7N 0W0
University of Wyoming, Laramie, WY 82070
Upper Colorado River Commision, 355 S. 4th East St., Salt Lake City, UT 84111
USDA-Forest Service, 1960 Addison Street, Berkeley, CA 94704-1177
US Army Corp of Engineers, Hanover, NH 03755
US Geological Survey, University of Puget Sound, Tacoma, WA 98416
US Geological Survey Lib., Box 25046 Federal Center - 914, Denver, CO 80225
US Geological Survey Library, 345 Middlefield Dr., MS 955, Menlo Park, CA 94025
US Geological Survey, National Center - Ms. 950, 12201 Sunrise Valley Dr., Reston, VA 22092
Water Management Branch, 765 Broughton Street, Victoria, BC, Canada V8V 1X5
Water Resources Branch, 1001 W. Pender, Rm. 502, Vancouver, BC V6E 2M9
Watersaver Co. Inc., P.O. Box 16465, Denver, CO 80216
Yale University, 205 Prospect St., New Haven, CT 06511

PROCEEDINGS OF THE WESTERN SNOW CONFERENCE

TABLE OF CONTENTS

	Page
SUBLIMATION OF INTERCEPTED SNOW AS A GLOBAL SOURCE OF WATER VAPOR by R. A. Schmidt, and C. A. Troendle	1
SNOW SURVEYING COMES OF AGE IN THE WEST by J. Douglas Helms	10
40 YEARS OF SNOW COVER MEASUREMENTS IN FRANCE by Daniel Duband, and Christian Lallement	18
EXPANDING SCS'S REMOTE SENSING PROGRAM by Peter D. Cooper, Jon G. Werner, and Garry L. Schaefer	28
MINIMIZING MEASUREMENT ERRORS IN AUTOMATED SNOWPACK PROFILE TEMPERATURE MEASUREMENTS by Keith A. Sauter, and Bertrand D. Tanner	36
MONITORING SNOW GRAIN SIZE FOR PASSIVE MICROWAVE STUDIES by Richard Armstrong, and Albert Rango	46
PROPYLENE GLYCOL AND ETHANOL AS A REPLACEMENT ANTIFREEZE FOR PRECIPITATION GAUGES: DILUTION, DISPOSAL, AND SAFETY by Bruce J. McGurk	56
SNOWFALL-EVENT CLIMATOLOGY: The Finale by Jennifer Luppens Mahoney, and John M. Brown	66
ENVIRONMENTAL INFLUENCES ON SNOW ALGAL MICROBES by Ronald W. Hoham	78
WHERE HAS ALL THE SNOW GONE? SNOWPACK SUBLIMATION IN NORTHERN ARIZONA by Charles C. Avery, Leland R. Dexter, Robert R. Wier, William G. Delinger, Aregai Tecle, and Robert J. Becker.	84
PREDICTION OF SNOWMELT RATES AT A FORESTED ALPINE SITE IN NORTHERN UTAH by Keith A. Sauter, and Jeffrey J. McDonnell	95
HYDROLOGIC FLOWPATHS OF SNOWPACK RUNOFF IN A HIGH-ELEVATION CATCHMENT by Mark W. Williams.	103
APPLYING A CLIMATIC CHANGE SCENARIO TO A SEMI-DISTRIBUTED WATERSHED MODEL by Geoff Kite.	113
HARVESTING SNOW WHEN WATER LEVELS ARE LOW by Robert L. Jairell, and R. A. Schmidt.	121
A GIS-BASED METHOD OF MODELING THE WATER INPUT FROM RAIN-ON-SNOW STORMS, FOR REGULATION AND MANAGEMENT OF CLEARCUT FOREST HARVEST by Matthew J. Brunengo, Stuart D. Smith, and Stephen C. Bernath.	125
SIMULATION OF SNOWMELT IN A SMALL RANGELAND WATERSHED by Gerald N. Flerchinger, and Keith R. Cooley.	129
ESTIMATION OF 30 YEAR AVERAGE ANNUAL PRECIPITATION FOR SNOTEL SITES IN IDAHO by Philip S. Morrisey.	133

PREDICTING SNOW MELT AND STREAMFLOW VOLUMES IN THE ARKANSAS RIVER BASIN OF COLORADO	
by Ray C. Nickless	137
SNOWPACK LOSS COMPONENT FOR A WATER BUDGET MODEL USING A GEOGRAPHICAL INFORMATION SYSTEM FOR THE SAN JUAN AQUIFER BASIN IN NEW MEXICO AND COLORADO	
by Scott D. Waltemeyer, and John M. Kernodle	141
AN IMPROVED CARRYING CASE FOR SNOW TUBES	
by David R. Gluns, and Gordon Rose	146
SNOW MANAGEMENT IN THE RECLAMATION OF SODIC SOILS	
by H. Steppuhn, and D. Curtin.	150
Minutes of the Executive Committee	i
Minutes of the Business Meeting	vii
Attendance Roster	xii

MINUTES OF THE EXECUTIVE COMMITTEE
WESTERN SNOW CONFERENCE
JACKSON, WYOMING

The 60th meeting of Western Snow Conference Executive Committee was called to order at 1:45 pm, April 13, 1992, by the General Chairperson Dr. Albert Rango. The meeting began with introduction of the members of the Executive Committee and those representing Executive Committee members by proxy.

Albert Rango, General Chairperson
James Marron, Secretary
Barbara Sarantitis, Treasurer

Neil Berg, General Chairperson Elect
Gary Hester, Secretary Elect

Ex-officio Members
Robert Swanson, Alberta
Jack Hannaford, California

Executive Committee 1992-94

South Continental Committee
Tom Carroll, Minnesota, Chairperson
Richard Armstrong, Colorado, Acting Chairperson
E. Bruce Jones, Colorado, Ken Martin, Representative
Ken Wahl, Colorado, Scott Waltemeyer, Representative
Jon Werner, Virginia

South Pacific Committee
Ronald Jones, Arizona, Chairperson
Gary Freeman, California
Tom Henderson, California - Marice Roos, Representative
Harold Klieforth, Nevada
Richard Stein, California

North Pacific Committee
Douglas Golding, British Columbia, Chairperson
Donald Huffman, Oregon
Barbara Sarantitis, Oregon
Douglas Speers, Oregon
Don Sytsma, Washington, Jill Huntington, Representative

North Continental Committee
Gerald Beard, Montana, Chairperson - Phil Farnes, Representative
Keith Cooley, Idaho
Peter Palmer, Idaho
Phyllis Snow, Montana
Harold Steppuhn, Saskatchewan

Minutes of the 1991 Western Snow Conference Annual Meeting: Jim Marron

Jim Marron indicated that the minutes of the 1991 Western Snow Conference had been published in the 60th Proceeding of the Conference and moved that the minutes of that meeting be accepted as published. The motion to accept the minutes was seconded by Bob Swanson. The floor was opened to discussion and having non the vote was called. The motion passed unanimously.

Treasurers Report: Barbara Sarantitis

A copy of the treasurers report was distributed to each of the Executive Committee members. the balance at the end of the 1991 fiscal year was \$4813.90. No new major purchases are anticipated during this year. Question was asked about the absence of both of the payments

for the coffee breaks. One of the coffee break sponsors has not paid at meeting time. Some consideration should be given to the purchase of a printer for the Conference. The Conference should be cautious this coming year because it will be another off year due to the 50th meeting of the Eastern Snow Conference.

Election Report: Jim Marron

Ballot verification is being completed during this meeting. The North Continental Area had a tie for the Chairperson position. Richard Armstrong asked what the tenure of office to the executive committee was. The tenure of the Executive Committee begins in the year they are elected and lasts for two years. The election results were verified by Don Huffman and a letterhead was provided indicating the 1992-94 Executive Committee. Bob Swanson indicated that the letterhead should be corrected to indicate all of the individuals with Doctorates or that the title should be removed from all of the members of the Executive Committee. All titles will be removed from the letterhead.

1993 Western Snow Conference Annual Meeting: Albert Rango

The 61st meeting of the Western Snow Conference will be held in conjunction with the 50th meeting of the Eastern Snow Conference. Al reviewed the circumstances leading to the current location and arrangements. Al attended the Eastern Snow Conference in Guelph, Canada to represent the desires of the Western Snow Conference. Al was invited to attend the Executive Committee Meeting and made the Western Snow Conferences point that Atlantic City was not a desirable location for attendance by the Western Snow Conference. The Eastern Snow Conference Executive Committee decided upon Quebec City, Quebec, Canada. It is a very desirable location and the meeting will be held at the Hotel Chateau Frontenac. The Hotel overlooking the Old City of Quebec. Meeting dates will be June 8-11, 1993 which is an extension to accommodate more papers. Neil Berg asked if the location was the monumental building shown in the brochure. Bob Swanson indicated that the building shown was the capitol building. Tim Pangborn forwarded a letter to the Western Snow Conference indicating the committee members for the 50th meeting and that the Western Snow Conference should be in contact with those individuals. Meetings to be aware of include the 49th Eastern Snow Conference Meeting in Oswego, New York from June 3-4, 1992. At that meeting they would like to discuss topics for the 50th meeting of the Eastern Snow Conference. The second meeting will be in October, 1992, in Quebec City, to discuss arrangements and to have a representative of the Western Snow Conference to discuss final arrangements. Tom Carroll has indicated that he will attend the first meeting in Oswego, New York, and Neil Berg will attend the meeting in Quebec City. The proceedings of each of the conferences represent an outstanding issue. John Metcalfe indicated that the 50th meeting of the Western Snow Conference is the issue that the Eastern Snow Conference has the most leftovers from. This would indicate that we need a very good estimate of how many need to be printed. The Eastern Snow Conference has their printing done by CRREL and it is kind of expensive costing \$3400 for 200 copies. Additional copies should not be reasonable because the count threshold has been reached. The method of printing is also an issue and a discussion on the desirability of having one printing with two covers, two separate printings, or one cover one printing. A Publication policy difference is also an issue. Examples of the Eastern Snow Conference publication policy were distributed to the Executive Committee for their review. The Eastern Snow Conference uses a two column format with very specific requirements for graphs, units, and insertion of figures and tables. Proceedings will not cost more for the joint meeting. Keith Cooley indicated that the double column is more difficult to complete. The final indication was that the publication committee needed to make contact with the publisher and the Eastern Snow Conference arrangements committee to rectify the issues. It was indicated that two separate covers would be preferable to a single cover. Al did make a plea that as many members as possible attend the meeting to make good our promise to provide good attendance. An announcement for the meeting should go out as soon as possible to excite the membership of the Western Snow Conference.

1994 Western Snow Conference Annual Meeting: Al Rango

The meeting was up in the air due to the Eastern Snow Conference meeting. Al felt that we needed to come up with a very choice meeting location for the 1994 meeting to get the Conference back on a roll. The South Continental wanted to hold a meeting in New Mexico, and the choice city was Santa Fe. Al discussed this choice with Ken Martin, Herb Garn, and Scott Waltemeyer and they all agreed that it would be very nice to have it in Santa Fe. Al visited Santa Fe and he and the others began to check with the hotels in Santa Fe downtown.

Al was then bombarded with material from the numerous hotels in the area. The end result is that Santa Fe would like the Conference to come there and it would be a choice location for the Conference. Al is certain we would have a good turn out because of the desirability of the location. The downtown hotels are currently too expensive for the per diem rate. The current rate is \$73. Many of the hotels in Santa Fe can meet the rate and even beat it with no real contact or discount. The Mesa Inn came in at \$65, the Pacheco Plaza Hotel, previously the Sheriton, would meet the federal per diem rate, with a double at \$83, and the Inn at Laureto would meet the federal per diem rate, with a double at \$90. Scott Waltemeyer visited the Inn at Laureto. He indicated that it was just one block off the plaza and had many shops and restaurants. The hotel indicated that if we had 100 rooms sold that we would be able to obtain the meeting rooms for free. He also indicated that there was a shuttle, on a set schedule of once every two hours, from the airport that leaves passengers off right at the hotel and costs \$8.00. Scott Waltemeyer and Ken Martin would be the local arrangements committee. Bob Swanson indicated that Santa Fe was an excellent place to meet and was very excited about the possibility. He also suggested looking into the La Pesada Hotel. Al indicated that they do not have the capability to hold large meetings. South Pacific indicated that they had no problem with holding the meeting in Santa Fe and Mauri Roos immediately made the motion or second whichever was necessary to bring it to a vote. Al called for the discussion and having non the vote was called for. The vote was unanimous to hold the 1994 annual meeting of the Western Snow Conference in Santa Fe, New Mexico. Formal arrangements would be required by the next meeting of the Executive Committee.

Awards Committee Report: Jack Hannaford

Jack Hannaford asked that any member of the Executive Committee that is aware of retirements or deceased members should provide Jim Marron with their names.

The best paper and best poster paper presentation awards are the responsibility of the technical program committee. Jack indicated that the technical program committee could use any criteria to decide on the best presentations. Jack did indicate that he would like to get the names of the selectees for those two awards prior to the banquet.

The El Farsante is well in hand. Jack indicated that there has been enough paper passed around the table to take care of at least one nominee. He stated that each of the Area Chairpersons are responsible for submitting one nominee and only one at the banquet. Time should be limited to no more than three minutes. Prior to the banquet Bob Brown will be meeting with the Area Chairpersons to finalize arrangements for the banquet.

Barbara Sarantitis has been responsible for the James E. Church award for the past couple of years and gave the report on this years recipient. Again Barbara Sarantitis will make the announcement at the banquet.

Wilderness Committee Report: Jack Hannaford

Jack Hannaford reported that California is again dealing with snow measurements in the Wilderness. Jack indicated that there would be at least one meeting at this Western Snow Conference with those individuals involved in this situation in California. The good news is that the Wilderness Committee has completed preparation of the Wilderness Resolution of the Western Snow Conference the so-so news will be provided by Jim Marron in his report. Jim Marron indicated that all the material that was to be provided to members of the congress was provided but that things got a little gray after that. The gist of last years actions were that because of the upcoming elections that action on wilderness was severely curtailed and that very little would be decided until after the elections. Very little action has been taken on any of the outstanding Wilderness bills. The resolution was to be sent to the states with outstanding Wilderness bills which included Montana, and Idaho. Montana and Idaho still have outstanding Wilderness bills that will probably not be considered this year. The only proposal that there seems to have been a resolution to is Montana and Phil Farnes indicated that the bill may pass this session. We will continue to identify the Wilderness bills still outstanding and provide the Wilderness Resolution to those Senators and Representatives. Neil Berg asked who was going to do this in the future. The resolution would not be sent to whole house and senate for passage. Phil Farnes indicated that there was no issue with reference to the wording in the Montana

Wilderness bill pertaining to data sites in Wilderness. Phil indicated that the language was as good as we were going to get but it was still open to interpretation. Phil indicated that the Western Snow Conference interfering in the process may be very detrimental to the bill passing and affect its final content. Jim indicated that in Idaho there was an issue with the way the bill was written and that we may want to send the resolution at that time. Jim Marron indicated that he would continue to work with the Wilderness Committee. Multistate Wilderness bill was being proposed by Congressmen from the Eastern US and may become an issue in the future. Ken Martin indicated that there was a New Mexico bill being considered for low elevation areas.

Publication Committee Report: Jim Marron

The Eastern Snow Conference joint meeting publication issues were discussed under the 1993 meeting. The publication committee, the General Chairperson, and the Secretary will represent the Conference in determining how the 1993 meeting will be handled.

Bob Richards gave a short report on the preparation of a new bibliography. He indicated that the bibliography was about 95% complete on entry of the information into Data Perfect. The bibliography will be completed through 1991. 1992 will not be included because that may further delay the release of the bibliography. Disks can be updated at each of the Western Snow Conference meetings with whatever computer is available at the time. When completed the bibliography will be sent to Bob Swanson. Bob Swanson will then convert the data files to a run time version of dbase 4. The bibliography will then be distributed to the membership for the price of the disk and postage.

Jim indicated that the editor of the Western Snow Conference Proceedings has been Bernie Shafer for the last 10 years. Bernie has taken on a new job in Fort Collins that requires so much time that he will no longer be able to remain as editor. Chuck Troendle and Jim Marron have discussed the situation and have decided that Chuck should be the Editor, Jim Marron would be the documents manager, and Chuck and Jim would find a third person to function on the publications committee. The previous process included submission of the papers at the annual meeting, the papers were forwarded to Bernie who reviewed the papers for publication policy violations, and then they were returned to the secretary for addition of the minutes, forward, contents page, and numbering. The Proceedings were then sent to Chuck Troendle for publication. Harold Steppuhn has already volunteered and will act as the reviewer for the Canadian documents and handling the Canadian documents. Jim Marron pointed out that some consideration should be given to a change to the two column format. Al Rango indicated that the publication committee should give some kind of recommendation.

Manuscript deadlines was another issue raised at the meeting by Al Rango. The deadline for this years deadline was set for April 1 with the primary reason being that the manuscripts were more safely handled in Portland reducing potential damage and lost sections. There has been some concern that the papers are due before the presentation instead of one month later. Bob Swanson motioned that the manuscripts deadline be made May 1. Harold Steppuhn indicated that there were insufficient papers for the conference and then the paper was due prior to the conference. Harold Steppuhn seconded the motion. Harold Steppuhn indicated that papers, if it is not already being done, should be numbered. Jim Marron indicated that the policy stated that the pages should be numbered in the margin in blue. Bob Swanson asked how far we were from submitting papers by disk. Jim indicated that we were a long way and that was primarily because of the large number of word processors being used to prepare documents. We have been trying to resolve the problem and have only found one format that might produce a solution and that is RTF but not all word processor can produce that format. We could suggest that we will settle on a word processor and a format and that individuals can submit manuscripts with those requirements. The discussion was ended and a vote was called for on the manuscript deadline date of May 1. The vote to have May 1 as the deadline for all manuscripts was unanimous.

Old Business: Albert Rango

Membership Certificate: Jim Marron

Jim provided copies of the membership certificate to the Executive Committee. Robert Swanson asked that the year sticker be the color of the area the individual currently resides in. Jim indicated that it would be possible to do that and that the cost was not substantial.

New Business: Albert Rango

1995 Western Snow Conference Annual Meeting: Ron Jones

The 1995 meeting host state is Nevada. We do not have a specific spot but we have had several calls and mailings from local hotels. Hal Klieforth and Kelly Redmond are both available to help with the local arrangements. Ron asked that anyone with a suggestion for a theme provide those to him during the next few months. Narrowing odds in the nineties was suggested as a possible theme.

Operations Transfer: Jim Marron

This past year we operated under the new constitution with the full impact of those changes occurring this year. Functions associated with the Secretary include the minutes, dues payments, and balancing the books. At the end of each fiscal year the books of the conference will be audited by the General Chairperson and Secretary elect. This means an auditor will be in place at all times. Financial book auditing will be taken care of by Neil Berg and Gary Hester. The remainder of the Western Snow Conference materials will be given to Neil and Gary by Wednesday evening. All membership, schedule, and materials pertinent to the Western Snow Conference are in the Conference computer. Mailings are processed by sending those documents to be mailed to the Western Snow Conference mail box. They are transferred to Copy Kats who print, fold, and stuff the envelopes. The mailing is then transferred to one of two mailing houses, Mail and More the most probable, to be distributed to the membership. The publications committee now takes care of preparation and distribution of the proceedings themselves. Jim Marron will remain as the Secretary through the business meeting at which time Gary Hester will become the Secretary of the Western Snow Conference. The General Chairperson Elect then assumes the General Chair at the end of the banquet and identifies, to the general membership, the General Chairperson Elect. The General Chairperson Elect has not been resolved yet but will be resolved prior to the banquet. Bob Richards asked Jim to clarify who the auditor would be each year. Jim indicated that the General Chairperson Elect and the Secretary Elect would act as auditors each year. This provides an opportunity for the General Chairperson Elect and the Secretary Elect to become more familiar with what is going on and who is involved.

Membership Standing and Operations: Harold Steppuhn

Membership mailings have increased substantially over the past years. Corporate memberships have declined with a qualification. Mailings to corporate members have declined but the number of corporate members who pay have gone up. The distinction between contributions and how much you paid was never defined. Several of the Corporate Members were not paying. Many of the Proceedings were being provided to Corporate Members who were not paid up. We now have categories of Corporate Membership as well as general purchasers. Purchasers are billed first and then proceedings provided. Corporate Members who have been in good standing will receive the proceedings even if prepayment has not been received. The second year of non-payment Corporate Members are notified and then dropped if payment is not received. General Membership rotates in a pattern that finds about 30-50% of membership in a particular year will drop and be replaced by members in the area where the meeting is being held. There is approximately 175-200 members that consistently renew their membership with that number growing slowly. Harold is concerned with the number of individuals attending the annual meeting. Tremendous changes have also occurred in many other organizations. Harold Steppuhn suggested that an add-hoc committee be formed to look at increasing the viability of the organization. He realizes that the committee would not be able to look at everything but could look at some alternatives. Al asked if this committee would look at things we have written guidelines for and those things we do not and subsequently make those things available to the Executive Committee. Phyllis pointed out that the International Snow Science Workshop held in Montana did some very nice things and that the committee could look at those meetings for ways to improve. Harold pointed out that there are groups that we could begin looking at to contribute to the Western Snow Conference. Groups like those interested in snow loads and ski area operation and safety. Al asked if the group would evaluate the state of health of the organization and make recommendations to the Executive Committee as to potential actions that could be taken. This would go with the openness of the organization as it is now. Al suggested that we jump ahead because this particular committee would be under Neil Berg and would be up to him to appoint the committee. Jim Marron pointed out that the Western Snow Conference is at a decision point as to its position on growth. We have to have new members to continue

but we are at a point where we need to decide if we are going to become an AWRA, probably extreme, or remain the same. This committee and its assignment will be transferred to Neil Berg for action.

The Wilderness Issue Meeting for California will be discussed at 8:00 pm this evening in the Timberline III.

Peter Palmer reviewed the schedule for the rest of the day with the Executive Committee.

Al Rango adjourned the Executive Committee Meeting at 4:45 pm April 13, 1992.

MINUTES OF THE BUSINESS MEETING
WESTERN SNOW CONFERENCE
JACKSON, WYOMING

The 60th annual business meeting of Western Snow Conference was called to order at 4:30 pm at the Snow King Resort in Jackson, Wyoming on April 14, 1992.

Minutes of the 1991 Western Snow Conference Annual Meeting: Jim Marron

Jim Marron reported to the business meeting that a motion to accept the minutes of the Annual Business Meeting as published in the proceedings was made, seconded, and passed unanimously by the Executive committee.

Treasurers Report: Barbara Sarantitis

Barbara reported that the treasurers report was presented to the Executive Committee and was accepted. The report indicated that the Conference had a balance on hand on April 1, 1992 of 4,400, with no major outlays. The one major outlay that may occur in the next few years will be a printer for the computer. The computer was last years major expenditure. Next year will be a rather tight year due to the meeting with the Eastern Snow Conference so expenditures this year will be minimal.

Old Business:

1993 Western Snow Conference Annual Meeting: Albert Rango

Discussions were held last year aboard the ferry from Bellingham to Juneau. We had committed a long time ago to join forces with the Eastern Snow Conference in 1993 for their 50th Annual Meeting. The Eastern Snow Conference threw us a curve when the first suggestion was Atlantic City and there was some negotiation about the location. I attended the Eastern Snow Conference Meeting in Guelph where the decision was made to hold the 50th Annual Meeting of the Eastern Snow Conference in Quebec City, Quebec, Canada. The Western Snow Conference meeting date next year will be changed for this event to June 8 through 11, 1993. A couple of things will happen before that meeting. Tom Carroll will represent the Western Snow Conference at this years meeting in Oswego, New York, June 3 through 4. He will work with them on development of the topics for the meeting. Neil Berg will represent the Western Snow Conference in October, 1992 in Quebec City for the Eastern Snow Conference Executive Committee meeting. The final arrangements and preparations will be made at that meeting for the 50th meeting in June 1993. I am inviting all of you to put June 8 through 11, 1993 on your calendar as the 61st meeting of the Western Snow Conference. This is a great location and will be an outstanding meeting to attend.

1994 Western Snow Conference Annual Meeting: Albert Rango

The 1994 meeting of the Western Snow Conference will be held during on April 18-21, 1994. The meeting location will be Santa Fe, New Mexico. The local arrangements committee is forming now and is actively working to find accommodations for the meeting. The downtown area is the most desirable and some members of the committee are working with a local hotel. That hotel has stated that they will meet the federal per diem rate in 1994 with the double rate at just \$10 over the per diem rate. That meeting will be an exciting meeting for the Western Snow Conference because we will have just finished one meeting with the Eastern Snow Conference and will be getting back into the swing of things.

Awards Committee Report: Jack Hannaford

Jack asked that members who are aware of any members that retired this last year or those that have passed away should inform the Secretary about those individuals. This individuals names will be announced at the banquet. The Best Paper and Best Poster Presentation will be announced at the banquet. The Dr. J.E. Church award will also be announced at the banquet. This award is a scholarship award to an outstanding Reno High School Senior in Science. The last but not least is the El Farsante award. Jack asked

that the Area Chairmen meet in the timberline room to discuss with the awards committee the likely recipients of the El Farsante award. Jack asked that the secretary leave room in the minutes to report on the recipients of the awards at the banquet. Jack did indicate that within the first four minutes of the Executive Committee meeting that there was enough material to award the El Farsante. The awards committee is always looking for new worthy candidates.

Wilderness Committee Report: Jack Hannaford

Last year the Wilderness Committee put the final touch on the Western Snow Conference Wilderness Resolution. The Resolution expressed the position of the Western Snow Conference on wilderness. Jack indicated that Jim Marron would report on the status of the Resolution. Jack did indicate that California still had a remaining issue with the measurement of snow in wilderness. The main point of concern was the existence of devices to measure snow in the wilderness and the need for their existence in wilderness. Jack then asked Phil Farnes to provide current information on the wilderness bill in Montana. Phil indicated that there may be a wilderness bill passed this year for Montana. He indicated that the bill contained language that would provide for access to and installation of measurement devices in wilderness areas in Montana. Some room for interpretation remains in the bill but Phil indicated that it was probably as good as it can be and further action on the part of the Western Snow Conference may be more damaging than productive.

Jack then asked Jim Marron to give his report. Jim indicated that the Resolution was in good shape and the new wording from last year was in the Resolution. The course of action from this point on the Conference will identify wilderness bills that are at issue and provide copies of the Resolution to try to influence the incorporation of more friendly wording toward installation of measurement devices and direct measurement of the snow resource for the management of water resources. The Conference will make a mailing to all of the House or Senate when that action becomes appropriate. Al then asked for any further comments on the Wilderness Committee report.

Publication Committee Report: Chuck Troendle by Jim Marron

Jim Marron gave a short report on the preparation of a new bibliography. He indicated that the bibliography was almost complete and that once it was complete that any member could get the bibliography by simply paying for the disk and mailing to receive it or by bringing a disk to the Western Snow Conference Annual Meeting where the new material can be appended. The bibliography will be on a run time version of dbase 4 and will contain the abstract as well as bibliographic material. A question did come up on additional of recent years and Jim indicated that Bob Swanson's experience with the produce that recent material can just be added on to the run time version.

The joint meeting of the Eastern and Western Snow Conference was the next point of discussion. There are several issues associated with the joint meeting. The Eastern Snow Conference has an entirely different format, 40 column, than we use in the West. The Western Snow Conference will need to coordinate with its publisher, Colorado State University, to see if there will be any difficulty in the Western Snow Conference not publishing for one year. The Eastern Snow Conference prints its proceedings through CREL and the only issue associated with that printing is the cover. The options include a single cover or two separate covers for the proceedings. The publication committees will need to work out those issues.

Jim Marron indicated that Bernie Shafer the editor of the Western Snow Conference Proceedings for 10 years has resigned from that position. Chuck Troendle and Jim Marron are the remaining members of the publication committee. Discussion resulted in Chuck becoming the Editor and Harold Steppuhn will become a member of the committee to help serve the Canadian contingent better.

Two issues came out of publication committee discussions. The first issue concerned the manuscript deadline. The Executive Committee resolved the issue by setting the manuscript

deadline as May 1. The second issue concerned the Conference Proceedings format. Many of the other Societies, Associations, and Conferences have converted to the 40 column side by side format including the Eastern Snow Conference. Individuals preparing papers for the Western Snow Conference and other meetings must prepare two papers because of the formats required. The publication committee will review the Western Snow Conference format and make a recommendation at next years Executive Committee meeting.

Membership Certificate: Jim Marron

Jim provided an example of the membership certificate and indicated that the certificate would be provided to members. The certificate indicates when you joined the Western Snow Conference and has room for membership years down the right side of the certificate. The stamp showing the year will be in the color of the area.

New Business:

1995 Western Snow Conference Annual Meeting: Ron Jones

Ron indicated that the 1995 meeting of the Western Snow Conference would be held in Reno, Nevada or near Lake Tahoe on the Nevada side. The South Pacific area has two members in the area that will be working on a location and facilities. Those individuals are Kelly Redmond and Hal Klieforth. Ron had no more details but indicated that the wheels are in motion for the meeting.

Western Snow Conference Operations Review: Jim Marron

The Conference has gone through many changes. Operations will now include a General Chairperson and a Secretary that will act in those positions for two years. There will also be a General Chairperson Elect who will locate a person willing to act as the Secretary of the Conference during the General Chairpersons term. The primary function of the General Chairperson Elect and that persons selection as Secretary will be to learn how the Conference operates and to act as an auditor for the books of the current Secretary and General Chairperson. The first transition to the new administration will be a change in Secretary which will happen shortly. The next transition will be at the banquet where the new General Chairperson will take office and identify the new General Chairperson Elect.

Committee Duties and Functions: Jim Marron

Keith Cooley indicated that as a program chairperson you are not quite certain of all the things that must be done. You then make a few phone calls to find out what needs to be done and what is involved. Much of the information is available from the Secretary but Keith specifically requested that those duties be recorded and provided to the chair of the committee. The secretary will complete those documents and make it part of the information contained in the Western Snow Conference computer.

Ad Hoc Committee Formation: Albert Rango

An Ad Hoc Committee will be formed by the new General Chairperson to review the health of the Conference. An interim report will be produced for next years meeting providing preliminary results with the final report in 1994.

Introduction of the New Executive Committee: Albert Rango

The Executive Committee of the Western Snow Conference for the term 1992 through 1994 is:

North Continental Area:

Jerry Beard, Chairperson
Harold Steppuhn
Keith Cooley
Peter Palmer
Phyllis Snow

North Pacific Area:

Doug Golding, Chairperson
Don Huffman
Barbara Sarantitis
Doug Speers
Don Sytsma

South Continental Area:

Tom Carroll, Chairperson
Richard Armstrong
Bruce Jones
Ken Wahl
Jon Werner

South Pacific Area:

Ron Jones, Chairperson
Gary Freeman
Tom Henderson
Hal Klieforth
Dick Stein

Jim Marron asked permission of the general membership to destroy the ballots of the 1992 election. Jim called for a vote and it was unanimous. The ballots were destroyed by the Secretary of the Western Snow Conference.

Introduction of the New Secretary of the Western Snow Conference: Neil Berg

Neil Berg introduced the Secretary of the Western Snow Conference, Gary Hester, Head Forecaster for the California Department of Water Resources.

Al Rango then opened the floor for any new business not covered.

Myron Molnau indicated a person on the staff of the University of Nevada has been working on a book on Dr. J.E. Church and that you might be receiving a phone call for them to gather more information about activities in the West. The book should be finished in September 1993. The individual has reviewed the materials in the archives for the Western Snow Conference and Dr. Church is agast at the state of the archives. Myron suggested that someone investigate the state of the archives and what should be done to improve the archives.

Ron Hoham extended an invitation to the members of the Western Snow Conference to attend the Eastern Snow Conference. Al added to the comment stating that his reputation was on the line because he stated that a lot of members from the Western Snow Conference would attend.

A question was asked as to how the papers would be divided at the meeting next year. Al indicated that the meeting was extended an extra day to accommodate the extra papers to be presented. Tom Carroll will be discussing the topics and how papers will be accepted. The target is to have about the same number of papers that we usually have but that a larger number of them may need to be poster papers.

The annual business meeting adjourned at 5:15 pm April 14, 1992.

BANQUET DOINGS

The awards presented during the banquet included, the best formal presentation, R.A. Schmidt and Charles Troendle, the best poster presentation, R. A. Schmidt and Robert Jairell, and of course the El Farsante competition was tremendous including outstanding entries by many individuals. The winner going away was Jerry Beard. Jerry won mainly due to outstanding organizational ability that found him without a slide projector as late as one hour before the first presentation. Robert Jairell performed the duties of Master of Ceremonies very well controlling the rowdiness of the Conference Members during the evening. The Dr. J. E. Church Award will be presented to Neena Reddy by Hal Klieforth our Reno representative on the Conference Executive Committee. Neena also won the Air Force Math and Science Award and was a National Merit Scholar.

ATTENDANCE ROSTER

LAST NAME	FIRST NAME	BUREAU OR AGENCY	CITY	STATE	COUNTRY
Adams	Bob	US Bureau of Reclamation	Salt Lake City	UT	
Armstrong	Richard L.	U of Colorado CIRES	Boulder	CO	
Avery	Charles C.	N. Arizona University - Forestry	Flagstaff	AZ	
Barnaby	Gerald	Confederated Salish & Kootenai Tribes	Pablo	MT	
Beard	Gerald	Soil Conservation Service	Belgrade	MT	
Berg	Neil	USDA Forest Service	Berkeley	CA	
Birkeland	Karl	US Forest Service, WS Montana Aval. Cntr.	Bozeman	MT	
Bornemeier	Doug	PacifiCorp Electric Operations	Portland	OR	
Brown	John	NOAA/ERL/FS1	Boulder	CO	
	R. T.	Southern California Edison	San Marino	CA	
Brunengo	Matthew	MS PY12 - Div. of Geology & Natural Res.	Olympia	WA	
Castle	Glenn H.	USCE-Retired	Somerset	CA	
Cooley	Keith R.	USDA-Agricultural Research	Boise	ID	
Cooper	Peter	USDA Soil Conservation Service	St. Paul	MN	
Cross	Dr. Llewellyn L.	Consulting Hydrologist	Walpole	MA	
Day	Ted	US Bureau of Reclamation	Boise	ID	
Dearing	Bill	PUD #1 Chelan County	Wenatchee	WA	
Deets	Neil A.		Vernal	UT	
Donich	Tom	Meteor Communications Corporation	Kent	WA	
Duband		Electricity of France	Clamart		FRANCE
Elder	Kelly		Wilson	WY	
Farhat	Jody	COE - Missouri Riv. Dv.	Omaha	NE	
Farnes	Phillip	Soil Conservation Service	Bozeman	MT	
Fassett	Jeff	State Engineer	Cheyenne	WY	
Flerchinger	Gerald	USDA ARS - NWRC	Boise	ID	
Ford	Glenn	Indian and Northern Affairs	Whitehorse	YT	CANADA
Fox	Stan	Soil Conservation Service	Beaverton	OR	
Freeman	Gary J.	PGE-Hydro Generation Div.	San Francisco	CA	
Gilbert	Ted	USDA-Soil Conservation Service	Casper	WY	
Gleason	Andy	Montana State University	Bozeman	MT	
Gluns	David	Ministry of Forests	Nelson	BC	CANADA
Golding	Dr. Douglas	University of British Columbia	Vancouver	BC	CANADA
Graham	Jeff	Soil Conservation Service	Portland	OR	
Griffith	Don	North American Weather	Salt Lake City	UT	
Hannaford	Jack F.	Sierra Hydrotech	Placerville	CA	
Harrington	Jill	Meteor Communications Corp	Kent	WA	
Hartman	Robert K.	National Weather Service	Sandy	UT	
Helms	J. Douglas	Soil Conservation Service	Washington	DC	
Henderson	Thomas J.	Atmospherics Incorporated	Fresno	CA	
Hendrickson	Wade	Confederated Salish & Kootenai Tribes	Pablo	MT	
Hester	Gary	Calif. Dept. of Water Res.	Sacramento	CA	
Hoham	Dr. Ron	Department of Biology	Hamilton	NY	
Huffman	Don	Soil Conservation Service	Portland	OR	
Jairell	Robert L.	US Forest Service	Laramie	WY	
Jones	Ronald A.	Soil Conservation Service	Mesa	AZ	
Julander	Randy	Soil Conservation Service	Salt Lake City	UT	

LAST NAME	FIRST NAME	BUREAU OR AGENCY	CITY	STATE	COUNTRY
Kite	Geoff	Hydrometeorological Research Div.	Saskatoon	SK	CANADA
Kjosnes	Ole	Seattle City Light	Seattle	WA	
Klieforth	Harold E.	Desert Research Institute	Reno	NV	
Koch	Roy W.	Dept of Civil Engineering, PSU	Portland	OR	
Lallemand		Electricity of France	Clamart		FRANCE
Leavesley	George H.	US Geological Survey WRD	Lakewood	CO	
Mahoney	Jennifer L.	NOAA/ERL/FS1	Boulder	CO	
Marron	James K.	USDA Soil Conservation Service	Beaverton	OR	
Martin	J. Kenneth	Soil Conservation Service	Albuquerque	NM	
McDanold	Jim	Office of the State Engineer - Colo	Denver	CO	
McGillivray	Grant T.	Environment Canada	N. Vancouver	BC	CANADA
McGurk	Bruce J.	US Forest Service	Berkeley	CA	
McGurty	Brian M.	So. Calif. Edison Co. - Hydro Gen.	Rosemead	CA	
Minter	Ben	Corps of Engineers	Portland	OR	
Molnau	Myron	Agricultural Engineering Dept.	Moscow	ID	
Morrisey	Philip	Soil Conservation Service	Boise	ID	
Nickless	Ray C.	Nation Weather Service - RFC	Tulsa	OK	
Palmer	Peter L.	USDA Soil Conservation Service	Boise	ID	
Pardee	Jack G.	Calif Dept of Water Res.	Sacramento	CA	
Perrault	Jim	Los Angeles Depart. of Water & Pwr	Los Angeles	CA	
Powell	Douglas R.	UC Berkeley	Berkley	CA	
Rango	Albert	USDA Agriculture Research Service	Beltsville	MD	
Richards	R. P.	BC Ministry of Environ	Victoria	BC	CANADA
Roos	Maurice	California DWR	Sacramento	CA	
Sarantitis	Barbara C.	NOAA-National Marine Fisheries Service	Portland	OR	
Schmidt	R.A.	USDA Forest Service	Ft. Collins	CO	
Skidmore	Peter	Student	Bozeman	MT	
Smith	Dale	Meteor Communications Corporation	Kent	WA	
Snow	Phyllis Jeanne	Flathead NR, US Forest Service	Kalispell	MT	
Speers	Douglas D.	Corps of Engineers, NPD	Portland	OR	
Stannard	Linda	US Geological Survey	Lakewood	CO	
Steppuhn	Harold		Swift Current	SA	CANADA
Stethem	Chris	Snow Safety Services	Canmore	AB	CANADA
Swanson	Angela	Meteor Communication Corporation	Kent	WA	
Swanson	Robert H.	Swanson & Associates	Canmore	AB	CANADA
Sytsma	Don	Meteor Communications Corporation	Kent	WA	
Tarboton	David G.	Utah Water Research Lab	Logan	UT	
Troendle	Charles	USDA Forest Service	Ft. Collins	CO	
Verbrugghe		Electricity of France	Clamart		FRANCE
von der Heydt	Lisa	Bonneville Power Administration	Vancouver	WA	
Wahl	Kenneth	USGS Denver Federal Cntr	Lakewood	CO	
Waltemeyer	Scott D.	USDI Geological Survey	Sante Fe	NM	
Washichek	Jack		Ft. Collins	CO	
Weiss	Eric	BC Hydro, Operations Hydro., Burnaby Mtn.	Vancouver	BC	CANADA

LAST NAME	FIRST NAME	BUREAU OR AGENCY	CITY	STATE	COUNTRY
Weller	William F.	SCS, Rock Pointe Tower II, Suite 450	Spokane	WA	
Werner	Jon G.	Soil Conservation Service	Herndon	VA	
Whaley	Bob	Soil Conservation Service - Retired	Boise	ID	
Williams	Mark W.	INSTAAR Department of Geography	Boulder	CO	

WESTERN SNOW CONFERENCE BIBLIOGRAPHY

SUBLIMATION OF INTERCEPTED SNOW AS A GLOBAL SOURCE OF WATER VAPOR

SCHMIDT, R.A.*, AND TROENDLE, C.A.**

Proc. WSC 1992: Pgs. 1-9, Jackson, Wyoming April 14-16, 1992
8 Figures; 17 References

Considering the vapor loss from grains on the snow surface produced a model to predict the sublimation rate of snow intercepted on conifer branches. Experiments to test this model showed that the controlling environmental factors, temperature, humidity, radiation, and wind speed, were properly accounted for. These results, combined with other experiments on the redistribution of snow by wind, show that most of the water increase associated with timber harvest in snow country may be attributed to reduced sublimation losses. If so, then up to a third of snowfall may return directly to the atmosphere from forest canopies. The paper compares the significance of timber harvest with climate change in influencing the magnitude of this component of the global water balance.

*Hydrologist, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado

**Principal hydrologist, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

WSC No. 923-92

Catalogue No.

CRREL No.

SUBJECT INDEX

1. Global water balance
2. sublimation
3. redistribution

AUTHOR INDEX

1. Schmidt, R.A.
2. Troendle, C.A.

WESTERN SNOW CONFERENCE BIBLIOGRAPHY

40 YEARS SNOW COVER MEASUREMENTS IN FRANCE

DUBAND, DANIEL*, AND LALLEMENT, CHRISTIAN*

Proc. WSC 1992: Pgs. 18-27, Jackson, Wyoming April 14-16, 1992
5 Figures; 1 Tables; 9 References

For nearly 40 years, EDF (French National Electricity Board) has been using a snow survey network in order to forecast snowmelt inflow for the purpose of water management (hydropower optimization, agriculture, water-sports...) during the end of winter, spring and summer. This network, set up at altitudes between 800 m and 2700 m consists of 240 manual gauging sites (having dropped from 650 in the late 60's), in Alps - Pyrenees - Central range mountains.

Meanwhile, in order to get real-time data, EDF has developed an original automatic level gauge service: the "TELENIVOMETER". This equipment can measure, once a day or more, the density of different layers of snow (10 cm slices) the snowdepth and the air temperature and thus deduces the water equivalent. The data can be collected by satellite (ARGOS) or by telephone for lower-altitude sites.

*French Electricity National Board (EDF) - General Engineering Division (DTG) - Water Resources Department - 37 Rue Diderot - BP 41 - 38040 Grenoble, France.

WSC No. 925-92

Catalogue No.

CRREL No.

SUBJECT INDEX

1. France snow cover measurements
2. multipurpose water management
3. water management

AUTHOR INDEX

1. Duband, D.
2. Lallement, C.

WESTERN SNOW CONFERENCE BIBLIOGRAPHY

SNOW SURVEYING COMES OF AGE IN THE WEST

HELMS, J. DOUGLAS*

Proc. WSC 1992: Pgs. 10-17, Jackson, Wyoming April 14-16, 1992
22 References

The Bureau of Agricultural Engineering's coordination of the snow surveying activity was transferred to the Soil Conservation Service in 1939 along with several other operations of the bureau's divisions of irrigation and drainage. The move linked the snow survey operations with an agency which worked directly with many of the main clients of snow survey--the irrigation farmers. The move added the assistance of SCS's field staff.

This paper recounts the growth of water supply forecasting in the 1930s and 1940s with special emphasis on the snow survey network, publicity, concerns about the accuracy and improvement of forecasts, and uses of water supply forecasts including its value for predicting floods.

*National Historian, Soil Conservation Service, Washington D.C.

WSC No. 924-92

Catalogue No.

CRREL No.

SUBJECT INDEX

1. snow survey coordination
2. SCS field staff
3. water supply forecasting growth

AUTHOR INDEX

1. Helms, J. Douglas

WESTERN SNOW CONFERENCE BIBLIOGRAPHY

EXPANDING SCS'S REMOTE SENSING PROGRAM

COOPER, PETER D.*, WERNER, JON G.***, AND SCHAEFER, GARRY***

Proc. WSC 1992 Pgs. 28-35, Jackson, Wyoming April 14-16, 1992
2 Figures; 1 Table; 6 References

The Soil Conservation Service (SCS) is involved in an effort to expand its application of meteor burst communications from Western water supply forecasting into other resource management concerns. A pilot site was installed in Sherburne County Minnesota in May 1990. Local SCS offices have begun utilizing the site's meteorological data for Evapotranspiration (ET) estimates. These ET estimates are made available to landowners for irrigation scheduling. The irrigation scheduling program is part of an SCS/Extension Service Water Quality Demonstration Project aimed at reducing nitrogen loading to groundwater in the Anoka Sand Plain area.

Beginning August, 1991 the Minnesota site, along with ten other new installations east of the Rockies were equipped with meteorological and soil moisture and soil temperature sensors. This newest phase in SCS resource inventory operations is aimed at demonstrating the

*Hydraulic Engineer, SCS, 375 Jackson, St. Paul, Minnesota 55101.
**National Hydrologist, SCS, PO Box 2890 Washington D.C.
***Supervisory Hydrologist, SCS, 511 NW Broadway, Rm 248, Portland, Oregon 97209-3489.

WSC No. 926-92

Catalogue No.

CRREL No.

SUBJECT INDEX

1. Climatic data
2. Remote sensing
3. SNOTEL
4. Meteor Burst
5. Water Quality
6. Global change

AUTHOR INDEX

1. Cooper, Peter D.
2. Werner, Jon G.
3. Schaefer, Garry

WESTERN SNOW CONFERENCE BIBLIOGRAPHY

A TECHNIQUE FOR LIMITING ERROR IN SNOW TEMPERATURE MEASUREMENT

SAUTER, K.A.*, AND TANNER, B.D.*

Proc. WSC 1992: Pgs. 36-45, Jackson, Wyoming April 14-16, 1992
6 Figures; 1 References

Snowpack profile temperatures were measured hourly during the 1991 winter season in the Bear River Mountains of northern Utah. A mono-filament fish line ladder was constructed to support a 20 junction chromel-constantan (Type E) thermocouple (TC) string in the Snowpack. To minimize conductance, 0.25 mm TC wire was routed along the ground surface, up and horizontally across 10 cm spaced ladder rings. Hourly, a datalogger measured each TC junction 10 times and calculated an average temperature.

During the season, a maximum cavitation of 1 cm in diameter and 2 in depth was observed around the mono-filament support structure. Under isothermal conditions (T_{snow} = 0 degrees C), TC temperatures were within +0.05 C of 0.0 C. Effects from surface conductance was evident in upper snowpack temperatures to an approximate depth of 20 cm.

*Campbell Scientific, Incorporated, P.O. Box 551, Logan, Utah 84321.

WSC No. 927-92

Catalogue No.

CRREL No.

SUBJECT INDEX

1. Snowpack profile temperatures
2. Thermocouple
3. Conductance

AUTHOR INDEX

1. Sauter, K.A.
2. Tanner, B.D.

WESTERN SNOW CONFERENCE BIBLIOGRAPHY

PROPYLENE GLYCOL AND ETHANOL: A REPLACEMENT FOR GLYCOMETH AS AN ANTIFREEZE IN PRECIPITATION GAUGES

McGURK, BRUCE J.*

Proc. WSC 1992: Pgs. 56-65, Jackson, Wyoming April 14-16, 1992
3 Figures; 3 Tables; 10 References

Federal and state agencies have used a 40 percent ethylene glycol - 60 percent methanol solution (glycometh) as an antifreeze solution in precipitation gauges for over 25 years. Current and future disposal regulations, however, make the continued use of the toxic glycometh unfeasible. Propylene glycol (PG) and denatured ethanol have been identified as likely substitutes for glycometh because they have similar characteristics but have low toxicity levels. This paper reports on cold room experiments (0 to -40 degrees C) to ascertain the freezing point of five different mixing ratios of PG and ethanol (PGE) in ten dilutions (1:0 to 1:7) with water. Little difference in freezing point was found across the five mixing ratios, so solution density and cost are important in recommending the best mixing ratio. An equation combines factors such as annual precipitation and minimum January temperature to predict the quantity of PGE that is required as a "charge" at a precipitation gauging site.

*Cumulative Effects and Inland Fish Unit, Pacific Southwest Research Station, U.S.D.A. Forest Service, P.O. Box 245, Berkeley, California 94701.

WSC No. 929-92

Catalogue No.

CRREL No.

SUBJECT INDEX

1. Ethylene glycol
2. Methanol
3. Toxic glycometh
4. freezing point
5. solution density

AUTHOR INDEX

1. McGurk, Bruce J.

WESTERN SNOW CONFERENCE BIBLIOGRAPHY

MONITORING SNOW GRAIN SIZE FOR PASSIVE MICROWAVE STUDIES

ARMSTRONG, RICHARD*, AND RANGO, ALBERT**

Proc. WSC 1992: Pgs. 46-55, Jackson, Wyoming April 14-16, 1992
7 Figures; 22 References

The application of passive microwave radiometry to the remote sensing of snow properties is based the ratio of emitted to scattered portions of the upwelling radiation. Increased scattering is indicative of increased snow amount (i.e., the number of snow grains present). However, scattering is directly proportional to snow grain size for a given snow amount. Current snow cover retrieval algorithms produce inaccurate results when snow grain size are unusually large. Therefore, it is necessary to characterize snow grain size on a regional scale (and perhaps a local scale in extreme situations) in order to adjust passive microwave retrieval algorithms. Preliminary analysis indicates that: (1) retrieval algorithms are not as sensitive to grain size as theory would indicate; (2) average grain size data may serve to characterize the detailed stratigraphy of the total snow cover, and; (3) conditions in subfreezing snow which produce grains that greatly exceed a diameter of 1-2 mm result from snow cover-climate relationships which can be modelled or monitored on a regional scale.

*CIRES/NSIDC, University of Colorado, Boulder, Colorado 80309

**USDA Hydrology Laboratory, Agricultural Research Service, Beltsville, Maryland 20705

WSC No. 928-92

Catalogue No.

CRREL No.

SUBJECT INDEX

1. Passive microwave radiometry
2. upwelling radiation
3. snow grain size

AUTHOR INDEX

1. Armstrong, Richard
2. Rango, Albert

WESTERN SNOW CONFERENCE BIBLIOGRAPHY

SNOWFALL-EVENT CLIMATOLOGY: The Finale

MAHONEY, JENNIFER LUPPENS*, AND BROWN, JOHN M.*

Proc. WSC 1992: Pgs. 66-77, Juneau, Alaska April 12-16, 1992
8 Figures; 2 Tables; 6 References

Two distinct types of snowfall events that produce heavy snow along the Front Range of Colorado are discussed in Part 2 of the snowfall-event climatology. A 40-year snowfall-event archive was used as the basis for the study. The additional analyses of synoptic surface and upper air maps, soundings and quasi-geostrophic diagnostics led to the identification of two distinct synoptic patterns, which we shall refer to as a Four Corners Low and a Southeast Colorado Low.

The Four Corner Lows were characterized by surface high pressure of arctic region to the north of Colorado with a cyclone to the southwest of the state, shallow upslope below 700 mb capped by an inversion layer with southwesterly winds above, and lack of synoptic-scale forcing of vertical motion. The Southeast Colorado Lows featured an intense surface cyclone over the southern High Plains associated with a strong upper trough or closed low, deep upslope flow over northeast Colorado, a jet from the northeast quadrant 750 and 500 mb, and strong vertical coherence in the synoptic-scale forcing of vertical motion. We will present examples of each synoptic

*NOAA/ERL/Forecast Systems Laboratory, 325 Broadway R/E/PS1, Boulder, Colorado 80303.

WSC No. 930-92

Catalogue No.

CRREL No.

SUBJECT INDEX

1. Climatology
2. Synoptic scale patterns
3. Colorado winter storms
4. Snowfall event

AUTHOR INDEX

1. Mahoney, Jennifer Luppens
2. Brown, John M.

WESTERN SNOW CONFERENCE BIBLIOGRAPHY

ENVIRONMENTAL INFLUENCES ON SNOW ALGAL MICROBES

HOHAM, RONALD W.*

Proc. WSC 1992: Pgs. 78-83, Jackson, Wyoming, April 14-16, 1992
19 References

Microbes called snow algae are worldwide in their distribution from alpine and polar environments. These microbes have been reported from 13 western states during the time of snowmelt. They occupy extreme conditions of cold temperature, acidified snow, high irradiation levels, and minimum nutrients for growth during snowmelt and summer drought after snowmelt. Snow algae color the snow green, orange or red, and environmental factors influence the distributions of individual species. A recent study of red snow from Wyoming and red and green snow from Antarctica shows differences in pigment ratios, fatty acid ratios and total nitrogen content. In another study, closely related snow algae from the White Mtns., Arizona, and the Adirondacks, N.Y., appear to have lost their capacity to reproduce sexually, but several observations of abnormal sexual reproduction have been observed. These reproductive strategies may be important for the survival of snow algae in the natural environment.

*Department of Biology, Colgate University, Hamilton, New York 13346

WSC No. 931-92

Catalogue No.

CRREL No.

SUBJECT INDEX

1. snow
2. microbes
3. algae
4. ecology
5. physiology

AUTHOR INDEX

1. Hoham, Ronald W.

WESTERN SNOW CONFERENCE BIBLIOGRAPHY

PREDICTION OF SNOWMELT RATES AT A FORESTED ALPINE SITE IN NORTHERN UTAH

MCDONNELL, J.J.*, AND SAUTER, K.A.*

Proc. WSC 1992: Pgs. 95-102, Jackson, Wyoming April 14-16, 1992
5 Figures; 10 References

This study examined snow surface energy exchanges in the forested Bear River mountains of northern Utah. The site was located a Beaver Mountain (2600 m) on a northeast aspect slope and instrumented to measure net radiation, incoming and reflected shortwave radiation, air temperature, soil temperature, snow temperature, relative humidity, wind gradients, snow temperature, relative humidity, wind gradients and direction, snow depth, and precipitation. Measurements were taken every 30 seconds and averaged over 30 minute intervals. The data was transmitted daily 32.9 km to Logan, Utah via radio telemetry.

Strong winds and warm, humid air preceded frontal weather systems passing over the Bear River mountains. Nevertheless, maximum daily average recorded wind speed was only 1.6 m/s, and the mean daily average was just 0.57 m/s. Snow surface energy exchanges were determined by bulk aerodynamic equations. Low momentum exchange resulted in net radiation dominating the surface energy budget. Over

*Watershed Science Unit, Department of Forest Resources, Utah State University, Logan, Utah.

WSC No. 933-92

Catalogue No.

CRREL No.

SUBJECT INDEX

1. snow surface
2. energy exchanges
3. melt season
4. net radiation

AUTHOR INDEX

1. McDonnell, J.J.
2. Sauter, K.A.

WESTERN SNOW CONFERENCE BIBLIOGRAPHY

WHERE HAS ALL THE SNOW GONE? SNOWPACK SUBLIMATION IN NORTHERN UTAH

AVERY, CHARLES C.*, DEXTER, LELAND R.*, WIER, ROBERT R., DELINGER, WILLIAM G.*, TECLÉ, AREGAI*, AND BECKER, ROBERT J.**

Proc. WSC 1992: Pgs. 84-94, Jackson, Wyoming April 14-16, 1992
11 Figures; 3 Table; 15 References

Climatic data for twenty-one winters was used to construct an index to assess the significance of evapo-sublimation at Flagstaff, Arizona. Large intra- and inter-annual variability was noted in the record using this "sublimation opportunity index" as well as a similar one based on ("corrected for") the presence of a snowcover.

An instrument to record evapo-sublimation has been developed and preliminary data is presented which compares values from this "sublimimeter" to the index values for periods in 1990-91 and 1991-92. While the index is not a predictive model, relatively good ($r^2 = 0.62$, cross-correlation coefficient = 0.89, cross association value = 79%) agreement is found between the index values and the observed values.

It appears that at least 22% and as much as 70% of the snowpack at this high elevation site may be lost to sublimation and, therefore, that the date of snowpack accumulation is critical to the runoff efficiency of high elevation snowpacks.

*Northern Arizona University, Flagstaff, Arizona.

**The Navajo Nation, Window Rock, Arizona.

WSC No. 932-92

Catalogue No.

CRREL No.

SUBJECT INDEX

1. sublimation opportunity index
2. evapo-sublimation
3. sublimimeter

AUTHOR INDEX

1. Avery, Charles C
2. Dexter, Leland R
3. Wier, Robert R.
4. Delinger, William G.
5. Teclé, Aregai
6. Becker, Robert J

WESTERN SNOW CONFERENCE BIBLIOGRAPHY

HYDROLOGIC FLOWPATHS OF SNOWPACK RUNOFF IN A HIGH-ELEVATION CATCHMENT

WILLIAMS, MARK W.*

Proc. WSC 1992: Pgs. 103-112, Jackson, Wyoming April 14-16, 1992
5 Figures; 17 References

High-elevation basins will show hydrologic and hydrochemical effects from global or regional climate change much sooner than will basins located at lower elevations. The combination of small hydrologic storage in groundwater reservoirs, the predominance of intrusive igneous rocks that weather slowly, the thin acidic soils, large amount of precipitation, and low buffering ability of alpine basins result in high-elevation areas of the Sierra Nevada responding quickly to changes in the quantity and quality of precipitation. In particular, global or regional climate change may increase both the magnitude and frequency of floods from snowpack runoff. Hydrologic and hydrochemical effects of snowpack runoff are a function of the path water takes as it leaves the snowpack and moves towards surface waters. It is essential to understand hydrological flowpaths in high-elevation basins if we are to forecast the hydrologic and hydrochemical consequences of a changing climate.

SUBJECT INDEX

1. regional climate change
2. global climate change
3. hydrochemical effects
4. high-elevation basins

AUTHOR INDEX

1. Williams, Mark W.

*Department of Geography and Institute of Arctic and Alpine Research, Campus Box 450, University of Colorado, Boulder, Colorado 80309.

WESTERN SNOW CONFERENCE BIBLIOGRAPHY

WSC No. 935-92

APPLYING A CLIMATIC CHANGE SCENARIO TO A SEMI-DISTRIBUTED WATERSHED MODEL

Catalogue No.

GEOFF, KITE*

CRREL No.

Proc. WSC 1992: Pgs. 113-120, Jackson, Wyoming April 14-16, 1992
5 Figures; 2 Tables; 19 References

Atmospheric general circulation models (GCMs) predict major changes in the earth's climate due to and expected doubling of atmospheric greenhouse gases such as CO₂. Watershed models have been used to estimate the effects of the changed climate on water resources but these models have generally assumed that the watershed itself will remain unchanged. It is more likely that a changing climate will change the distribution and the transpiration efficiency of vegetation. A semi-distributed hydrological model was applied to a watershed in the Rocky Mountains of British Columbia. The watershed was divided into a number of sub-basins and each sub-basin was divided into land-use zones. The paper discusses the methods available for linking the output of the GCM to the watershed model and discusses the results of the application in terms of the model responses.

SUBJECT INDEX

1. Watershed models
2. Climatic change

AUTHOR INDEX

1. Kite, Geoff

*National Hydrology Research Institute, 11 Innovation Blvd., Saskatoon, Saskatchewan S7N 3H5, CANADA.

WESTERN SNOW CONFERENCE BIBLIOGRAPHY

WSC No. 936-92

HARVESTING SNOW WHEN WATER LEVELS ARE LOW

Catalogue No.

JAIRELL, ROBERT L.*, AND SCHMIDT, R.A.*

CRREL No.

Proc. WSC 1992: Pgs. 121-124, Jackson, Wyoming April 14-16, 1992
3 Figure; 2 Table; 9 References

Designing a snow fence-pit-berm water source for livestock of wildlife on the High Plains begins by estimating available snow transport, from average winter snowfall and fetch distance along the drifting wind direction. Pit excavation must match this volume of water. The pit will then trap one-half the snow transport. A snow fence height is chosen to provide storage for the one-half of snow transport not stored by the pit. The snow fence, pit, and berm are extended across the wind to match the water requirements (number of animals, number of days of use). Cost is less than most wells with pumping systems.

SUBJECT INDEX

1. livestock water source
2. High Plains
3. water source
4. fence-pit-berm

AUTHOR INDEX

1. Jairell, Robert L.
2. Schmidt, R. A.

*Research Technician and Hydrologist, respectively, USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Laramie, Wyoming in cooperation with the University of Wyoming.

WESTERN SNOW CONFERENCE BIBLIOGRAPHY

WSC No. 937-92

A GIS-BASED METHOD OF MODELING WATER INPUT FROM RAIN-ON-SNOW STORMS FOR MANAGEMENT AND REGULATION OF CLEARCUT FOREST HARVEST

Catalogue No.

BRUNENGO, MATTHEW J.*, SMITH, STUART D.*, AND BERNATH STEPHEN C.

CRREL No.

Proc. WSC 1992: Pgs. 125-128, Jackson, Wyoming April 14-16, 1992
5 References

Timber harvest has helped transform the Northwest into a patchwork of cities, farms, clearcuts, plantations, and mature trees, surrounding fragments of primeval forest. Forest canopy affects snow accumulation and melt, particularly during rain-on-snow storms; harvest has thus caused changes in water systems at various scales. The management environment has also changed, with increased attention to protection of woodland resources.

DNR now regulates harvest with regard to water input during R/S events. The key layer of our GIS-based system is a map of precipitation zones, based on snow available for melting (used partly to determine which forest-practices applications are examined for R/S implications). Modeling of snowmelt during hypothetical events allows estimation of water reaching the soil in each polygon. Differences between inputs under fully-forested and current vegetation suggest changes in effective storm frequency. Results are used to predict hydrologic effects of harvest scenarios.

*Forest Practices Division, Washington Department of Natural Resources, Olympia, Washington 98504-7012.

SUBJECT INDEX

1. Rain-on-snow storms
2. Harvest
3. Precipitation zones

AUTHOR INDEX

1. Brunengo, Matthew
2. Smith, Stuart D.
3. Bernath, Stephen

WESTERN SNOW CONFERENCE BIBLIOGRAPHY

WSC No. 938-92

SIMULATION OF SNOWMELT IN A SMALL RANGELAND WATERSHED

Catalogue No.

FLERCHINGER, GERALD N.*, AND COOLEY, KEITH R.*

CRREL No.

Proc. WSC 1992: Pgs. 129-132, Jackson, Wyoming April 14-16, 1992
5 Figures; 8 Table

Snowmelt simulation of the Simultaneous Heat And Water (SHAW) model was tested by applying the model to two years of data from three sites on a rangeland watershed ranging from transient snow cover on a west-facing slope to a deep snow drift on a northeast-facing slope. The SHAW model is a point energy and mass balance model and simulates a one-dimensional profile extending from the snow, residue or soil surface to a specified depth within the soil. The model's ability to simulate heat and water movement through plant cover, snow, residue and soil has been demonstrated, but the accuracy of the model in predicting snowmelt outflow has never been tested. The timing and magnitude of simulated hourly and daily snowmelt compared well with measured values. Results suggest that the SHAW model can be applied successfully to predict snowmelt from diverse rangeland sites.

SUBJECT INDEX

1. snowmelt modeling
2. hydrologic modeling
3. energy balance

AUTHOR INDEX

1. Flerchinger, Gerald N.
2. Cooley, Keith R.

*Research Hydraulic Engineer and Hydrologist, respectively, USDA-ARS, Northwest Watershed Research Center, 800 Park Blvd., Suite 105, Boise, Idaho.

WESTERN SNOW CONFERENCE BIBLIOGRAPHY

WSC No. 939-92

ESTIMATION OF 30 YEAR AVERAGE ANNUAL PRECIPITATION FOR SNOTEL SITES IN IDAHO

Catalogue No.

MORRISEY, PHILIP S.*

CRREL No.

Proc. WSC 1992: Pgs. 133-136, Jackson, Wyoming April 14-16, 1992
3 Figures; 2 Table

The Soil Conservation Service (SCS) operates and maintains a network of 69 automated SNOTEL (SNOW TELEmetry) sites in Idaho. Most have a continuous daily precipitation data record from 1982. 1961-1990 average annual precipitation (AAP) was estimated for 65 of the sites having more than five years of data using simple linear regression. Water year annual precipitation for the available years was compared to nearby National Weather Service (NWS) stations. Up to 14 NWS stations were analyzed for each SNOTEL site. The three highest correlating NWS sites for each SNOTEL site were selected and the 1961-1990 AAP at the NWS sites was used to estimate three 30 year AAP values for each SNOTEL site from the regression equations. The final 1961-1990 AAP for the SNOTEL sites was the mean calculated from the three individual values. High correlations were consistently obtained between SNOTEL and NWS annual precipitation.

SUBJECT INDEX

1. SNOTEL sites
2. daily precipitation
3. 30 year average annual precip

AUTHOR INDEX

1. Morrisey, Philip

*Hydrologist, USDA Soil Conservation Service, 3244 Elder Street, Boise, Idaho 83705.

WESTERN SNOW CONFERENCE BIBLIOGRAPHY

WSC No. 941-92

SNOWPACK LOSS COMPONENT FOR A WATER BUDGET MODEL USING A GEOGRAPHICAL INFORMATION SYSTEM FOR THE SAN JUAN AQUIFER BASIN IN NEW MEXICO AND COLORADO

Catalogue No.

WALTEMEYER, SCOTT D.*, AND KERNODLE, JOHN M.*

CRREL No.

Proc. WSC 1992: Pgs. 141-145, Jackson, Wyoming April 14-16, 1992
2 Figures; 4 References

A water budget model was applied to the San Juan basin aquifer New Mexico and Colorado. Direct recharge was estimated at the mouth of 272 surface basins. Mean annual winter precipitation for each surface basin was weighted upon the respective basin area and the isoline intersecting each basin using a Geographical Information System (GIS). Overall winter precipitation component was estimated at 8,600 cubic feet per second for the aquifer basin. Mean annual discharge for three distinct physiographic regions were used to estimate the streamflow component. The overall streamflow component was estimated at 2,670 cubic feet per second for the aquifer basin.

A snowpack loss component was determined from a relation of April 1 water content and a corresponding relation of average basin mean annual winter precipitation. The snowpack loss component was derived

SUBJECT INDEX

1. Water budget
2. physiographic regions
3. streamflow component
4. DEM

AUTHOR INDEX

1. Waltemeyer, Scott D.
2. Kernodle, John M

*Water Resources Division, U.S. Geological Survey, 1939 Warner Circle, Santa Fe, New Mexico 87501.

WESTERN SNOW CONFERENCE BIBLIOGRAPHY

WSC No. 940-92

PREDICTING SNOW MELT AND STREAMFLOW VOLUMES IN THE ARKANSAS RIVER BASIN OF COLORADO

Catalogue No.

NICKLESS, RAY C.*

CRREL No.

Proc. WSC 1992: Pgs. 137-140, Jackson, Wyoming April 14-16, 1992
2 Figures; 6 References

The National Weather Service (NWS) and United States Geological Survey (USGS) are conducting a cooperative study to predict snowmelt in the Arkansas River Basin of Colorado. Extended Streamflow Prediction (ESP) is being used to model the study area. ESP combines statistical frequency analysis with conceptual computer modeling to produce probability forecasts. observed historical streamflow, simulated historical streamflow, and conditional simulated streamflow are used to develop probability distributions for each data type.

Inflow volumes are being predicted for Pueblo Reservoir, Colorado during the spring and summer runoff periods. These volumes will be used by the U.S. Army Corps of Engineers to maximize reservoir storage. A comparison is being made between NWS-Soil Conservation Service Water Supply Forecasts and Extended Streamflow Prediction at selected water supply forecast points.

SUBJECT INDEX

1. Predict snowmelt
2. frequency analysis
3. inflow volumes

AUTHOR INDEX

1. Nickless, Ray C.

*Hydrologist, National Weather Service, River Forecast Center, 10159 E. 11th Street, Suite 300, Tulsa, Oklahoma 74128.

WESTERN SNOW CONFERENCE BIBLIOGRAPHY

WSC No. 942-92

AN IMPROVED CARRYING CASE FOR SNOW TUBES

Catalogue No.

GLUNS, DAVID R.*, AND ROSE, GORDON

CRREL No.

Proc. WSC 1992: Pgs. 146-149, Jackson, Wyoming April 14-16, 1992
2 Figures; 2 References

The need by snow surveyors and researchers to travel to remote snow sites by skis, snowshoes or snowmachines necessitates carrying snow tubes and survival equipment. This paper describes a new pack for carrying snow measuring equipment along with personal survival gear in a comfortable fashion and still offer protection to the equipment. The snow tube portion of the pack is removable for summer storage and allows for the main portion of the pack to used year round. First season field use of the pack is reported and input before commercial production is solicited.

SUBJECT INDEX

1. snow tubes
2. pack

AUTHOR INDEX

1. Gluns, David R.
2. Rose, Gordon

*Ministry of Forests, Forest Sciences Section, 518 Lake Street, Nelson, British Columbia, V1L 4C6, CANADA.

**Solitude Design, #311-2211 West 5th Avenue, Vancouver, British Columbia, V6K 1S4, CANADA.

WESTERN SNOW CONFERENCE BIBLIOGRAPHY

WSC No. 943-92

SNOW MANAGEMENT IN THE RECLAMATION OF SODIC SOILS

Catalogue No.

STEPPUHN, H.*, AND CURTIN, D.*

CRREL No.

Proc. WSC 1992: Pgs. 150-153, Jackson, Wyoming April 14-16, 1992
3 Figures; 4 References

Sodic Soils contain an excess of exchangeable sodium relative to other cations. This imbalance together with other conductive conditions cause soil aggregates to separate into smaller particles, alter the soil structure, restrict infiltration, and reduce permeability. Reclamation of sodic soils often includes the application of calcium amendments to displace and free the sodium for subsequent leaching. When irrigation water is unavailable, the rate of the reclamation depends on natural precipitation. Snow management to increase water quantities for these Ca-amended soils might facilitate and accelerate reclamation.

A trial in Saskatchewan using plastic snowfencing erected on small plots demonstrated that snow management practiced on highly sodic soil amended with Ca can improve water intake. Snowfenced plots accumulated water equivalents seven-fold greater (76 to 11 mm) than comparable unfenced plots. Upon melting, this snowcover enhancement supplied 41% more water and to deeper within the soil profile to 60 cm.

*Hydrologist and Soil Chemist, Agriculture Canada Research Station, P.O. Box 1030, Swift Current, Saskatchewan, S9H 3X2, CANADA.

SUBJECT INDEX

1. Sodic soils
2. Soil reclamation
3. Sodicity
4. Calcium amendments

AUTHOR INDEX

1. Steppuhn, H.
2. Curtin, D.