THE Avalanche REVIEW

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Heli Blasting at Crystal Mountain, April 3, 2011. With the previous mission producing an R5D4 result within the Crystal ski area, patrollers Paul Harrington and Christina Von Mertens find out how many explosives can fit in the back of a Hughes 500. ***Photo by Chris Morin***

see Crystal story on page 21

CRUST THOUGHTS

A rain event on Martin Luther King Jr weekend, 2011, produced a widespread and variable crust that caused avalanche events of different sizes, triggers, and time sequences. See page 20 for the rest of the crust stories.

Story by Karl Birkeland

Much of this issue of TAR is focused on crusts and how they affect avalanche conditions. In particular, Lynne asked readers for feedback on the so-called "MLK crust" formed in mid-January of 2011. I cannot comment directly on that crust event as it was not a big player in the Montana snowpack, and knee surgery around Christmas limited my field time. Despite my lack of knowledge of the MLK crust, Lynne still asked me to comment generally on crusts for this issue, so here are some fairly random musings on buried ice crusts.

When an ice crust is buried, seasoned avalanche practitioners keep careful track of it. We've been trained to recognize that even subtle changes in structure in the snowpack need to be monitored, and ice crusts clearly form dramatic discontinuities. Even if the snow surrounding the crust is well bonded initially, the changes in porosity and conductivity associated with a buried crust might well lead to snowpack weaknesses resulting in dangerous avalanche conditions. Sometimes when an ice crust becomes buried, the crust and the crystals around it become a season-long problem over a large area *(many examples exist, such as Jamieson and Johnson, 1997)*. However, other times a crust will form and be buried, and there will be no weakness whatsoever associated with it. Why the difference?

See story continued on page 20 ➡

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P.O. Box 2831
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in this issue

Even with crusts, what I call Ron Perla's First Law of Avalanche Forecasting – the only rule of thumb is that there are no rules of thumb – still applies!

—Karl Birkeland, *Crust Thoughts*, pg 20

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from the executive director

HURRY: There's Still Time to Update your Contact Info

AAA Executive Director Mark Mueller and the necessities of life: a cozy yurt, fat backcountry skis, more than just one PBR, and *The Avalanche Review*. Mark and his wife Sandy Kobrock are the proprietors of Wolf Creek Backcountry and the Pass Creek yurt outside Pagosa Springs, CO.

This past summer and fall we've sent out renewal reminders and meeting notices via Constant Contact, an online email marketing provider. We've included announcements regarding this transition to electronic communications in the first two issues of TAR this year. Your response has been great; it seems to have caught on. Thank you. This improves our administrative efficiency, which means keeping our operating costs low.

But, we haven't caught up with everyone, so we've extended the grace period to two issues of TAR so that you won't miss an issue while we transition to this new program. If you usually renew in the fall and you haven't renewed, this will be your last issue.

Unsure about your status or your renew date? It's easy to find out: go to avalanche.org and click on the "professionals" drop-down menu, then select "AAA Membership Directory." Remember, we need a current usable email address for you for renewal notifications and meeting announcements. AAA does not share or sell your contact information. Send us your email and mailing address updates anytime during the year to aaa@avalanche.org.

In the future as we continue transitioning to more complete online membership management, you will manage all your contact information online. When this transition will occur remains undecided – we want to make sure we get it right, but it will be soon and again, may take a little getting used to. Thanks in advance for helping make this new program a success.

We have new American Avalanche Association decals. Since we don't do much direct mailing anymore, just shoot me an email at aaa@avalanche.org with your mailing address, and I'll send you some while supplies last.

Winter is upon us. It's been a slow start in some locations, but it's been in full swing in the east San Juans of Colorado since early October. My first day on skis was October 7, and conditions were very good. I hope by the time you read this in early February you are enjoying some fine conditions as well.

I wish you all a safe and successful winter. *—Mark Mueller, AAA executive director*

from the editor

The editor's birthday, on Olive Oil, in Grand Teton National Park. *Photo by Dan Powers*

Wrestling with Powder Demons

I have been teaching avalanche classes for a couple of months now this winter, working with people, watching them get it, helping them use their new vocabulary in sentences and make appropriate decisions, albeit guided decisions in an institutional setting.

Right now, however, I am the skier that I warn students about in our Human Factor/ Backcountry Psychology classes. Just like most of you, we had a snow drought in the Tetons for much of November and December. Hardly anything was filled in enough to ski, and the bowls underlain by weeds and grass were mogulled like a ski area. We exercised patience and skate skied for fitness.

Then at New Years it began to snow hard; stability plummeted; we skied but we were afraid, stuck to low-angle slopes and the ski areas. Another recent storm brought 3+ inches of SWE to our mountains, closed Teton Pass for three days, and gave us ubiquitous red on the avalanche forecast. We dialed it back once again. Cold temps then gave us another 11+ 5 + whatever comes tonight, and I want to ski. I want to get into those steep filled-in trees and feel the pull of gravity and soft welcome of powder. I say to myself and my ski partners, "The drought surface is now 1.5 meters down, no whumphing or cracking today, let's go have a look." I have high desire and still some uncertainty. Life feels short, powder days at a premium. Where do I find the patience to draw back, to simply go poke around and gather information before making that appropriate decision?

Perhaps some insight into patience will come with this issue of TAR, reading Drew Hardesty's take on events in Little Cottonwood on November 13, 2011, when powder fever prevailed over assessment of consequence. I think of one element of my Backcountry Psychology presentation, the "pre-mortem test," where, in your mind's eye, you see yourself in the headlines of the next day's paper, or, as Mark Staples of the Gallatin puts it, your boss calls you in and says, "Now let me get this straight…"

I'll wrestle with the powder demons tomorrow, but tonight I want to introduce you to this issue of TAR, where we present you with many views of a widespread rain crust, both theory and particular case studies. My take-home lesson about crusts is actually that they are more complex than I ever considered. Cora Shea's sensitive imager and insights helped me see that, literally, while Chris Morin's meticulous analysis showed me the importance of a long-term understanding of the inter-relatedness of ALL the weather factors, and how a colorful spreadsheet really helps. Special thanks to Karl Birkeland, who amiably agreed to write on crust theory for TAR at the last minute; although he got an extra day beyond deadline to ski with his daughters on his birthday.

Finally, I want to thank many of the mentors of our avalanche world, whose insight continues to grace TAR. Ron Perla's story of the history of the Alta Schools and the National Avalanche School shows me that, as Ed LaChapelle told us in *The Ascending Spiral*, we are continually building on the ideas of those who came before. I sure would like to use some of Ron, Ed, and Monty's case studies in my own classes. Rod Newcomb reminds us of the Ram Penetrometer's usefulness in detecting vast differences in hardness, e.g., the MLK crust and its burden last spring; and Sam Colbeck gives us a nugget of understanding about temperature and crusts. Readers and mentors: share your thoughts and questions with TAR please.

For the final issue of the 30th year of *The Avalanche Review,* I plan to show you some photos, tell some stories of the slides that ran on the drought layer – do send material on as soon as possible for this topic please. I am also gathering opinions and ideas from guides, educators, anyone who is responsible for others in avalanche terrain; how do you dial your risk tolerance personally and programmatically? *—Lynne Wolfe*

metamorphism

Metamorphism in the CI Program

The process for change within the Certified Instructor (CI) program has been on the radar screen for the AAA Board for some time. These changes have been driven by the desire to improve the program, changes within the industry, and the AAA Education Committee. As we all know, the importance of quality and consistent avalanche education is paramount to saving lives for backcountry users; this has increased the responsibility for educators. AAA Certified Instructors are leaders in the education model and therefore need stay up to date with current teaching styles and avalanche curriculum as well as continue to be challenged.

The purpose of the program changes is multi-faceted. An informal committee including members of the Education Committee, myself, John Stimberis, Scott Savage, and Dale Atkins was formed to brainstorm ideas. Our goal is to improve the program and increase the credibility of avalanche education. We see AAA CIs as the "cream of the crop" in avalanche education and wish to increase the value of being a Certified Instructor. In the past year, we conducted a survey soliciting ideas from the CI pool. Feedback and ideas were greatly appreciated and have become part of the driving force for upcoming changes to the program.

Specific details of these changes are still being fleshed out; however, there are three main changes you can expect to happen soon. The biggest change will be concerning the application review process. In the past, one lead reviewer reviewed applicants. It is with sadness that we announce that our lead reviewer, Jerry Roberts, has stepped down from leading the program from its inception through the last 10 years. His dedication and service have been greatly appreciated and will be missed. The new review process will include not one reviewer but three, one of whom will be any current CI wishing to be more involved in the program.

Other big changes include requirements, recommendations involving Continuing Professional Development (CPD) credits, and a timeline to complete the process in order to maintain certification. A requirement example would be to maintain Professional Membership in the AAA. Examples of recommendations might include taking relevant classes, teaching classes, going to seminars or workshops, and/or doing research and other field studies. CIs will be able to use their imagination. The recommendations' purpose is to get CIs to challenge themselves – learning more and continuing their education. The timeline will likely be a three-year cycle.

We want to make the program as strong as it can be and grow with changing industry needs to increase the quality of avalanche education. Input from all Certified Instructors is welcome, so send your ideas and opinions to snosaw@gmail.com.

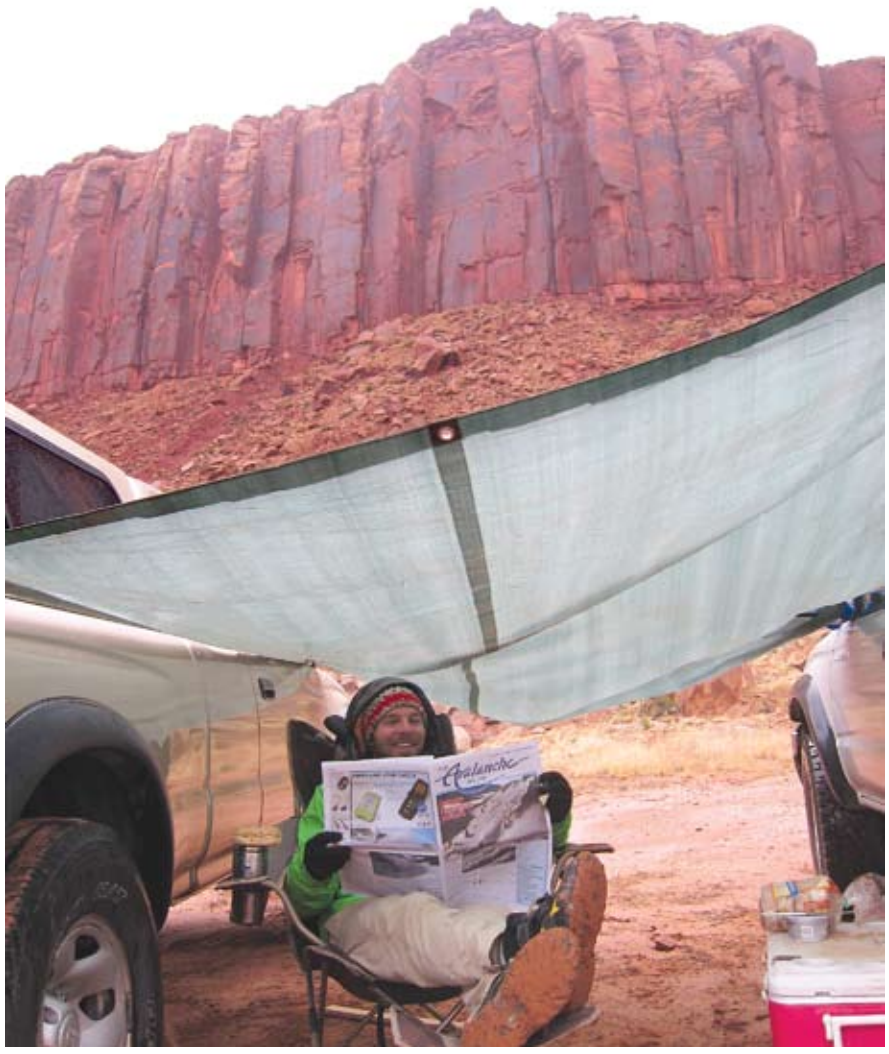
—Brad Sawtell, AAA Certified Instructor Representative to the Governing Board

Congratulations to Nick Meyers, Shasta-Trinity National Forest, who tells TAR he is happy to have officially been awarded the lead forecaster/ranger position (previously held by Eric White, who is now with the NWS in Hawaii) at the USFS. He is looking forward to a great winter season.

Congratulations also to these new Certified Instructors:

NEW CERTIFIED INSTRUCTORS

John Stimberis, Ellensburg, WA
Tom Thorn, Big Sky, MT
Eric Geisler, Anchorage, AK
Blase Reardon, Ketchum, ID
Aleph Johnston-Bloom, Durango, CO
Kent Scheler, Anchorage, AK
Mark Falender, Aspen, CO
Eeva Latosuo, Anchorage, AK
Gary Kuehn, Wanaka, New Zealand



TAR contributor Matt Primomo catches up on important avalanche news on a rainy day at Indian Creek. *Photo by by another TAR contributor, Ian Havlick.*

aaa news

AAA Research Funding Explained:

The how, what, who of research funding, along with some recent developments

You probably know that the AAA hands out research money every year to a number of worthy projects. But how do you get a piece of the action? And how does the AAA decide who gets what? This article answers these questions and others, by explaining the AAA research funding opportunities, updating you on some recent developments, and introducing you to the AAA Research Committee.

Through the Research Committee the AAA supports the mission of providing accurate information on snow and avalanches, facilitating technical transfer between research scientists and field practitioners, and promoting research into topics that increase our knowledge on snow and avalanche-related phenomena. The AAA has two calls for proposals each year (due September 1 & March 1): one for student research grants and one for practitioners. All grantees are required to write an article detailing their research to be published in *The Avalanche Review*.

GRADUATE STUDENT RESEARCH GRANTS

Since 2000 the American Avalanche Association has awarded research grants to graduate students conducting research on snow avalanches. Successful applicants have chosen research topics that embody the philosophy of the International Snow Science Workshop (ISSW), an international meeting of snow scientists and avalanche practitioners, "A merging of theory and practice." The AAA has allocated $1500 per year to this program and normally plans to fund at most two proposals each year. These applications are due by September 1 each year, in time for the fall AAA board meeting.

PRACTITIONER RESEARCH GRANTS

The AAA awards research grants to avalanche field practitioners conducting research on snow avalanches. Preference is given to proposals whose results will benefit avalanche field practitioners or will extend our understanding of snow and avalanche phenomena. Proposals should embody the theme of the ISSW. The AAA has allocated $1500 a year to this program, which will be used to normally fund at most two proposals annually. These applications are due by March 1 each year, in time for the spring AAA board meeting.

The research committee is charged with reviewing these applications and making a recommendation to the AAA board for funding. Up until recently, this review process was somewhat unstructured. While this did not affect the fairness or quality of the review process, it did (and could) provide for additional complexity for the research chair when making the final recommendation to the board. So to address this, a reviewer template has been designed, and this will be used from the next round onward (i.e., the practitioner grants due March 1, 2012). This reviewer template is intended to assist the research committee as reviewers of the research grants and to provide a transparent process for making recommendations to the board.

The reviewer template scores the following six criterion on a scale from 1 to 5:

1. Overall scientific & practical merit.
2. Alignment to the core theme of "a merging of theory and practice."
3. Potential outcome benefits to AAA membership.
4. Overall ability to deliver.
5. Technology transfer.
6. Organization and presentation of proposal.

As well as providing a numerical score, reviewers may provide comments to support the score as well as provide additional comments outside these main criterion.

This new process will aid clarity and transparency in the reviewing process and allow for more guidance when submitting applications. These grants are a great way to get small to medium projects started, so if you have an idea, then get busy writing and consider submitting an application this year. For more information and specific application guidelines visit www.americanavalancheassociation.org/grants_research.php.

That covers the old and new processes, but who reviews these proposals and makes the recommendations? The following section provides a short introduction bio to each of the 10 members of the research committee:

RESEARCH COMMITTEE

Jordy Hendrikx – Research Chair

Jordy Hendrikx is the director of the Snow & Avalanche Laboratory in the Department of Earth Sciences at Montana State University and the current AAA research chair. Jordy has undertaken research on snow, glaciers, avalanches, and climate change around the world, and he has considerable experience with applied research and road avalanche programs.

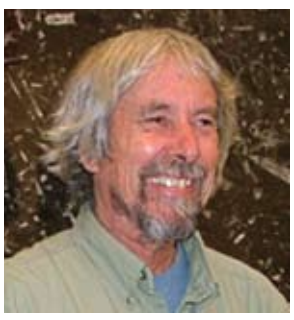
Prior to working for Montana State University, Jordy worked as a snow and ice scientist at NIWA (National Institute for Water and Atmospheric Research - the NZ version of NCAR) in Christchurch, New Zealand. Here he led a number of key projects on snow and ice research, including the development of a new national snow monitoring network, nationwide glacier monitoring, avalanche mapping and risk assessments, snow storm assessments, and snow-loading investigations. Before working for NIWA he completed his PhD at the University of Canterbury in New Zealand focusing on the Milford Road where he also worked as an avalanche forecaster and scientist. He has also spent time working as a researcher at the Swiss Federal Institute for Snow and Avalanche Research in Davos, Switzerland.

Karl Birkeland

Karl Birkeland is currently the acting director and an avalanche scientist for the USDA Forest Service National Avalanche Center, based in Bozeman, Montana. Karl has worked with snow and avalanches for the past 30 years. After seven years of professional ski patrol experience in Colorado and Utah, Karl earned his MS in earth sciences from Montana State University in 1990 doing research on snow-strength variability. He then founded the Gallatin National Forest Avalanche Center in Bozeman, where he worked as a backcountry avalanche forecaster, researcher, and educator for nine years. In addition to his avalanche forecasting work, Karl finished his PhD in geography at Arizona State University in 1997 researching snow avalanches. In 1999, Karl began work as an avalanche scientist for the Forest Service National Avalanche Center, where he cooperates with several universities and international research institutes to transfer new and emerging technologies to the Forest Service avalanche centers. He has successfully competed for a number of grants from the National Science Foundation and was awarded a Fulbright Grant to work in New Zealand in 2009. He has published several scientific articles and has taught the Snow Accumulation and Dynamics Class and a graduate seminar on Snow and Avalanche Processes at Montana State University, where he supervises a number of graduate students as an adjunct professor in the earth sciences department.

Martyn Clark

Martyn Clark received a PhD from the University of Colorado in 1998. Martyn worked as a research scientist at the University of Colorado's Cooperative Institute for Research in Environmental Sciences on a variety of topics including large-scale climate dynamics, land-atmosphere interactions, and applied hydro-climatology. In 2005, Martyn went to work for NIWA in New Zealand. In 2010, Martyn relocated back to Boulder, Colorado and works for the National Center for Atmospheric Research as a senior scientist. Martyn has an extensive publication record in areas of hydro-climatology including numerous papers focused on snow research.



Howard Conway

Howard Conway is a research professor in the Department of Earth & Space Sciences at the University of Washington. His scientific interests lie in glacier and ice sheet history, as well as snow avalanches. His research focuses on observing and modeling physical processes in snow-covered regions, their impacts on society, and their response to the changing environment.

He has a long history of working with road avalanche programs both in the US and in New Zealand. He has worked alongside Wayne Carran on the Milford Road for a number of years, researching various aspects of this extreme maritime snow avalanche environment. Howard was also one of the pioneers in spatial variability research with his work in New Zealand in the early 1980s.

Kelly Elder

Kelly Elder grew up skiing and climbing in the Intermountain snowpack of the Tetons. He started following Rod Newcomb like a homeless dog in the '70s, which started a long field career in snow research. A trip to Boulder, Colorado, to continue skiing and climbing deteriorated into an eight-year bachelor's degree, followed by hard time in Santa Barbara, California, where he earned a master's and PhD studying maritime snowpacks. Six more years in the Tetons led to a faculty position at CSU in Colorado where he taught a number of courses including three different snow courses. In 2000 he took a job as a research hydrologist at the USFS Rocky Mountain Research Station, which included running the Fraser Experimental Forest in Fraser, Colorado. There he continues a field-oriented research program that has included projects in Alaska, Asia, Baffin Island, Colorado, Chile, Wyoming, and the Yukon. He thinks the worst day in a snowpit beats the best day in the office. NSF, NASA, DOD, NWS, NPS, USDA, and other organizations have funded his research.

Andy Gleason

Andy Gleason teaches geology and snow science at Fort Lewis College in Durango, Colorado, in the Department of Geosciences. He has worked for Trautner Geotech in Durango since 2006 as a consultant on geological and geotechnical hazards associated with snow avalanche, rockfall, landslide, and debris flow. He has worked as a research scientist since 2006 for the Institute of Arctic and Alpine Research University of Colorado at Boulder, conducting research on snow hydrology and snow avalanches using Frequency Modulated Continuous Wave radar to correlate manual field data with radar data and remotely sensed data in high alpine basins.

Andy worked for the Colorado Avalanche Information Center as the lead highway avalanche forecaster on Red Mountain Pass from 1995 to 2004 at the Silverton Forecast Office and in the Boulder office until 2006. He also worked for the Colorado

Continued on next page ➡

AAA RESEARCH FUNDING

continued from previous page

Geological Survey from 2004 to 2006 as a geologist in Denver and in southwest Colorado in the summers from 1997 to 2004. Andy has worked in Montana and Chile as an avalanche forecaster. He has taught at avalanche schools around the country since the early 1990s and is a Certified Instructor with the AAA, and he also served as AAA secretary and executive board member. Andy has conducted research on snow avalanches since the early 1990s, and he served as the Papers Chair for the ISSW in 2006. He continues to conduct snow research for his doctoral studies. Andy is married and is father to two children ages 9 and 5 who keep him busy building tree houses in the summer.

Ethan Greene

Ethan Greene is the director of the Colorado Avalanche Information Center. He has approached snow and avalanches from both a practical and theoretical perspective. He grew up in Boulder skiing Colorado's Front Range. After a few winters in the San Juan Mountains, he worked at Big Sky Resort in Montana as a ski patroller and at the Forest Service Utah Avalanche Center in Salt Lake City as an avalanche forecaster. Ethan also studied meteorology at the University of Utah (BS) and snow drift formation at Colorado State University (MS). He has spent a lot of time looking at the microstructure of snow and its metamorphism in very large freezers in Colorado and Switzerland (PhD). Ethan has published a variety of articles on snow, weather, and avalanches and been a member of national and international working groups on snow and avalanche projects. Ethan lives in Fort Collins, and in the summer you can find him somewhere in the Cache la Poudre drainage.

Eric Lutz

Eric Lutz is a snow scientist with a broad interest in cold regions phenomena, researching avalanche formation, snow hydrology, and glaciology. Eric studied alpine geography at the University of Zurich (1998-2000), at SLF-Davos (2000-01), and at the University of Innsbruck (2001-03) where he earned the European Diploma (Mag. Rer. Nat.) in natural sciences with honors, with a master's thesis in remote sensing of glacial surfaces. In 2009 he earned his PhD in earth sciences at Montana State University, examining spatial patterns of persistent weak layers and determinants at the slope-scale. Eric subsequently completed a collaborative study in snow hydrology as a research associate in civil and environmental engineering at the University of Washington (2009-10), applying land surface and hydrological modeling to quantify the impacts of climate change on snowpack storage and subsequent streamflow in the Pacific Northwest. Since January 2011, Eric is a research associate in earth sciences at Dartmouth College, using field observations and remote sensing to characterize the state of snow and firn on the Greenland Ice Sheet. Eric has also spent time teaching science in elementary schools, instructing avalanche awareness and wilderness mountaineering courses, and he currently mentors undergraduate students and serves as a reviewer for numerous scientific journals.

HP Marshall – Former AAA Research Chair

Hans-Peter (HP) Marshall is an assistant professor in the Department of Geosciences and the Center for Geophysical Investigation of the Shallow Subsurface at Boise State University, and he is a consultant for the US Army Cold Regions Research and Engineering Laboratory. HP is a snow scientist and glaciologist who uses geophysics and engineering tools to study the cryosphere. He received his BS in physics from the University of Washington with a minor in geophysics, and he earned a PhD in civil engineering with an emphasis in geotechnical engineering from the University of Colorado at Boulder. He spent one winter at the Swiss Federal Institute for Snow and Avalanche Research as a visiting PhD student, and he recently received the 2010 AGU Cryosphere Focus Group's Young Investigator Award. His current research is focused on spatial variability in snow and its effect on remote sensing, snow hydrology, and snow avalanches. He was the research chair for the AAA from 2004 to 2011.

Ian Owens

Ian Owens recently retired from the geography department at the University of Canterbury after working there since 1973. He has a PhD from the University of Toronto which included a thesis on debris flows in the Canadian Rockies. After returning to New Zealand his research interests moved from geomorphology to snow and avalanche studies, working particularly on avalanche mapping for roads and walking tracks. He has also worked with associates in the geography department on glaciological investigations. He was fortunate to have supervised a number of very good PhD students working in snow and avalanche research and in mountain meteorology and hazards. He has been a member of the Snow and Avalanche Committee of the New Zealand Mountain Safety Council since its inception in 1977, convener of the committee from 1994 to 2004, and chair of the Mountain Safety Council (which includes the NZ version of the AAA) from 2001 to 2004.

—Jordy Hendrikx, AAA research chair

what's new

Above: A flashing sign in Little Cottonwood Canyon warns skiers.
Right: Looking over the howitzer located at Alta with Mt Superior in the background.
Photos courtesy Adam Naisbitt

UDOT Adapts to Dawn Patrol Challenges

Story by Chris Covington

The Utah Department of Transportation is responsible for safety on state roads in Utah. As part of that responsibility, UDOT maintains avalanche safety programs in Big Cottonwood Canyon, Little Cottonwood Canyon, American Fork Canyon, and Provo Canyon. Forecasters in these locations attempt to initiate avalanches using explosives while the road below is closed prior to reaching snowpack and weather conditions when natural avalanches that could reach the road are likely to occur.

Many of the areas where explosive avalanche control work is carried out for the roads are also backcountry skiing terrain. In the last 10 years the UDOT forecasters have seen a large increase in the number of people accessing highway avalanche starting zones for recreational skiing. UDOT's control work is most often done in Little Cottonwood Canyon, where access to the highway target zones is easiest and the greatest numbers of people are attempting to ski.

As pressure to ski the highway starting zones has increased, the program has evolved. The focus of UDOT's efforts has been to inform the public about the times and locations of control work through the following means:

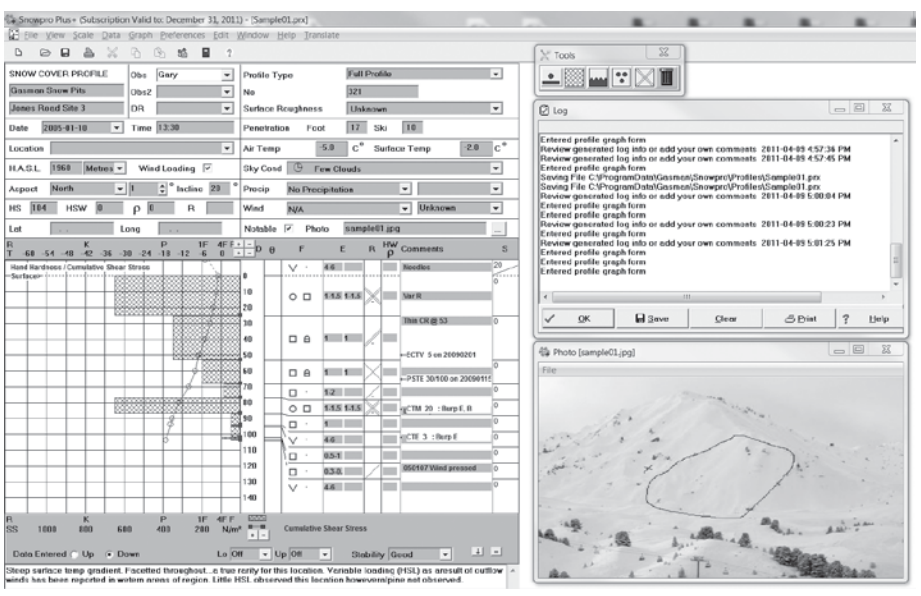
- Recorded message on a phone line
- Web site explaining closures
- Announcement on the Utah Avalanche Center home page
- Text message system
- Announcement on TGR Web forum's Wasatch thread
- Announcement on Tele Tips Web forum's Wasatch thread
- Permanent sign with flashing lights at the most-used access point
- Temporary signs with flashing lights placed at other access points prior to control work
- Two Town of Alta employees drive between the several access points within the town beginning at 3:30am on control mornings
- Two Alta marshals patrol the town looking for ski tourers until interlodge goes into effect
- One or two UDOT forecasters drive between the several access points within the town and lower in the canyon beginning at 4am on control mornings
- Loud siren sound 15 minutes prior to start of control work

On mornings when the road has remained open during the night and control work is scheduled, the road is commonly closed at 6am with interlodge going into effect at 6:30am. Between 4-6:30am the people patrolling the access points usually turn away five to 10 cars of ski tourers who had been planning to access the highway avalanche starting zones for skiing that morning.

This season, several additional steps have been added. The Alta Marshall's Office and the Unified Police Force (Salt Lake County) will institute public safety closures of the terrain where explosives control work will occur. This step of enforcing existing ordinances will make it illegal to be within the closure area until the closure is lifted. UDOT will add signage to explain this and will add two large electric signs along the road up Little Cottonwood Canyon to help disseminate information. This early winter, UDOT reached out to the local backcountry skiing community to explain these changes and to help prevent any misunderstandings of the new closures. Stay tuned to see how this goes.

Chris Covington lives up in Little Cottonwood Canyon within spitting distance of the sign with flashing lights. He is one of the lucky UDOT forecasters who patrols the road at 4am on control mornings.

Snowpro Plus+ Updates Software



The latest release of Snowpro Plus+ software includes versions of the Snowpro subscription, a free 15-day trial, and the free Snowpro viewer. Subscription users will be automatically updated.

A list of new features can be found at www.snowproplus.com/newfeatures30.htm and new users are invited to try a free 15 day full-featured trial at www.snowproplus.com/demorequest.htm

Snow profile analysis is a tool used by ski patrol and snow safety professionals to help determine whether specific layers in the snow pack are subject to skier-initiated avalanches. This is accomplished by digging snowpits in the target areas and recording layer snow temperatures, grain sizes and types, layer hardness, and other parameters. Various shear tests are performed to assess the stability of the snowpack. This information is presented in a snow profile.

Snowpro Plus+ is the premier snow profile graphing software which has been used for over 15 years worldwide to quickly and accurately produce the snow-profile graphs. The software is designed to provide high-quality plots of snow cover profile information according to the International Classification for Seasonal Snow on the Ground. It incorporates a method for plotting results of Ramsonde hardness measurements, the shovel shear test described in the National Research Council of Canada and Canadian Avalanche Association guidelines and also the Rutshblock system advocated by researchers at the University of Calgary. Other shear tests include compression, shear frame, deep tap, extended column, and propagation saw. Layer hardness can be plotted according to a system that approximates a ram profile. Snow and shear layers can be tagged with a "nickname" to track layers over progressive profiles. Save formats are based on XML, CSV, and JSON allowing easy data interchange with other related applications.

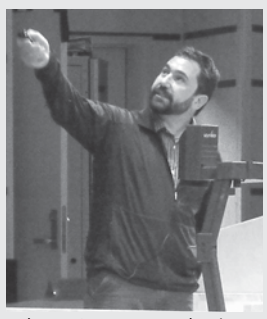
Conference organizers (l-r): Anne-Mari Planke; Erlend Sande; Krister Kristensen; Martine Løvold from the steering committee; Hedda Breien, program committee leader; Tor André Skjelbakken, technical committee leader; and Heidi Vigerust, steering committee.

Fifth Nordic Avalanche Conference Meets

Story by Krister Kristensen

In November 2011, the fifth Nordic avalanche conference was held in Tromsø, northern Norway. The biannual avalanche conference is modeled after the ISSW with the objective of bringing people together to discuss trends and experiences as well as new ideas and technologies for snow and avalanche safety. The conference is open to ski patrollers, avalanche forecasters, road maintenance personnel, ski guides, avalanche instructors, students, and researchers. About 250 participants and presenters from Norway, Sweden, Denmark, Iceland, and the United States attended the most recent Nordic avalanche conference.

Many of the talks focused on two topics currently affecting Nordic countries. First, we discussed the relatively new use of alpine ski equipment in the backcountry to scale peaks and then descend steep slopes as opposed to the old ski culture of long-haul ski tours between mountain huts in rather flat mountainous terrain (in the spirit of our polar explorer heroes). The equipment and the motivation of skiers have changed dramatically in Nordic countries over the last 20 years. One question raised was: have we seen an increase of avalanche accident because of this development? The answer is: probably not. The annual numbers are relatively small, but it is hard to see any clear trend for the worse. It could be that though people are using steeper slopes than before, general awareness of avalanches has also increased.



Ethan Greene spoke in Norway this November.

The second main topic was public avalanche forecasting. Norway has only had local and regional forecasting programs, mainly operated by the NGI and financed by users such as Road Administrations and local communities. Now a publicly financed test program has begun with the aim to have a national service up and running in 2013. For a North American perspective the organizers invited Ethan Greene from the Colorado Avalanche Information Center. Ethan gave two very interesting presentations and also represented the American Avalanche Association and *The Avalanche Review* during the conference.

For those who know Nordic languages, most of the presentations are available at www.ngi.no/no/snoskred/Lar-om-snoskred/Snoskred-og-frilufstsliv-2011/. The conference was well-organized by leader of the program committee Hedda Breien, NGI and the technical committee led by Tor André Skjelbakken, Tromsø Red Cross.

Krister Kristensen is the AAA European section rep.

APU Offers Undergrad Snow Science Program

Story by Eeva Latosuo

Would you like to ski or ride while you get an undergraduate degree? No, this is not an advertisement for Colorado Mountain College. The more precise question: Do you want to become a novice snow professional in a distinct student-centered undergraduate program in Alaska?

Alaska Pacific University is one of those hidden secrets in the fleet of private liberal arts universities. We are related to Prescott, Northland, and College of Atlantic, but with the location in Anchorage, we offer wild and remote settings for environmental and outdoor-related fields. The sustainable university of 550 students is intentionally small, ensuring that the class sizes are small and the relationships between faculty and students become personable and strong.

The Bachelor of Arts in outdoor studies prepares students for careers in outdoor recreation and education through expedition and classroom learning. Outdoor studies graduates develop strong skills in climbing, skiing, hiking, sea kayaking, and/or packrafting. More importantly they spend enough time in the field to be competent expedition leaders, truly appreciate the wild places we have in Alaska, and hold themselves to the highest professional and ethical standards in outdoor recreation.

One of the most popular concentrations within the degree is snow science. It all started with Nancy Pfeiffer offering "Snow Science for Professionals," an innovative semester-long avalanche course. In 10 years, this one-course wonder has grown into 30-credit concentration within a bachelor's degree. The graduates of the program have competency for snow-related careers such as ski patrolling, avalanche forecasting, and guiding. Students collaborate regularly with Alaska Avalanche School, Alyeska Ski Patrol, Chugach National Forest Avalanche Information Center, and Chugach Powder Guides. The graduates of the program are enjoying the outdoor lifestyle as patrollers and guides, and a few are making the move towards apprentice forecasting.

The coolest thing about the focused study plan is that in four to six semesters, students become grounded in field-based research in the world of snow by integrating snow science, meteorology, winter travel skills, and research methods. Students learn to recognize anomalous observations, propose working hypotheses, practice testing of hypotheses, and collect sufficient data for quantitative or qualitative analysis. All this while skiing or riding in Alaskan mountains and getting credit for it. Not bad.

APU is a student-centered university, and each snow science student develops a focused research project guided by their personal interest and skill set. These projects produce high-level undergraduate research in a wide variety of topics in the snow and avalanche field. APU snow science students have presented research posters at ISSW 2008 and 2010. This academic year we have six students conducting projects with high hopes of getting accepted to ISSW 2012.

Examples of research projects include:

International Snow Science Workshop 2008

- Applying ATES scale at Turnagain Pass
- Multi-agency avalanche SAR response in southcentral Alaska

International Snow Science Workshop 2010

- Avalanche path dendroecology at Chugach State Park
- Factors affecting efficiency of single shoveler in avalanche rescue
- Feasibility study for Chugach State Park avalanche center

APU snow science students dig digging pits in the early Chugach snowpack. *Photo by Sean Fallon*

- Avalanche terrain assessment for hut system in the Kenai Mountains
- The use of thermal imagers in snowpit

Projects 2010/11

- Does skier weight matter in slope cuts?
- Surface hoar through thermal imager
- Device disturbance with avalanche transceivers

Upcoming or Continuing Projects 2011/12

- Youth avalanche education initiative for Anchorage and Girdwood
- National survey of avalanche dog handlers on scenting conditions
- Testing procedure for the integrity of avalanche air bags
- GIS avalanche terrain analysis for Hatcher Pass
- Survey of avalanche hazard in dog mushing races in Alaska
- Avalanche hazard assessment for common ice climbing areas around Anchorage

Snow Science Concentration Course Flow

Prerequisite: Level 1 or Introductory Winter Wilderness Skills

- Mountain Weather
- Snow Science 1 ("Level 2 on steroids")
- Backcountry Skiing
- Snow Science 2 Field Research
- Meteorology

Recreation and Public Lands

- Pick two of the following courses *(8 credits)*
  - Glaciology & Glacier Travel
  - Winter Ecology & Cold Weather Physiology
  - Introduction to GIS
  - Climate Change
- Internship in Snow Profession
- Senior Project in the Field of Snow Science

Total: 31-40 credits

Faculty

Academic advisor for snow science concentration: Eeva Latosuo, assistant professor in outdoor studies, elatosuo@alaskapacific.edu

APU environmental science faculty involved with program: Michael Loso, Jason Geck, Rusty Myers

Adjunct faculty involved with the program: Brad Cosgrove, Sean McManamy

Alaska Avalanche Professionals Unite

Story by Eeva Latosuo

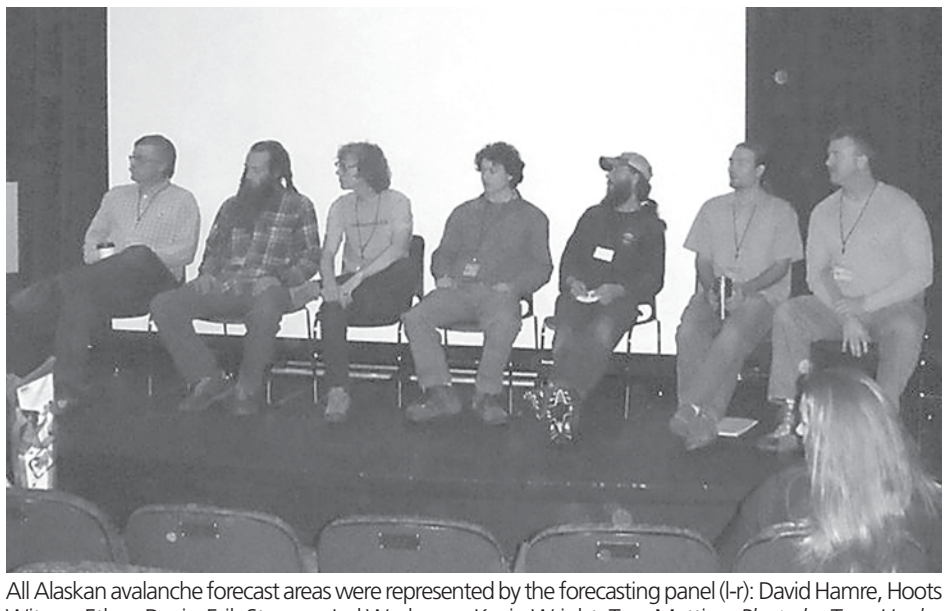
The first weekend of November brought 100 avalanche folks for the inaugural Alaska regional snow workshop hosted at Alaska Pacific University in Anchorage. The idea of having a statewide conference has been around for a while, but with ISSW 2012 around the corner, organizing a mini conference for the local community seemed like a timely idea. And the exciting part is that people came – forecasters, patrollers, guides, educators, students, and interested public. All the prominent avalanche communities of Alaska were represented: Girdwood, Valdez, Cordova, Haines, Juneau, and Anchorage.

Dave Hamre, the stalwart of the Alaskan snow scene, started the weekend off with a keynote speech on the "Perspective of Time." With 40 years of avalanche experience, Dave shared his epiphanies of avalanche work at Alta, Alyeska, and Alaska Railroad, and talked about the sense of time in forecasting. He also described the parallels of modern Alaskan forecasting with the '80s.

The conference agenda was jam-packed with presentations and panel discussions on Friday and work sessions on Saturday morning. Saturday afternoon's outreach component offered short presentations and rescue demonstrations to the public. One of the common threads throughout the weekend was snowmachine safety and avalanche education. The liveliest conversation was heard during the panel discussion, "What is the future of avalanche forecasting in Alaska?" True to the spirit of any snow conference, a more informal yet important activity was the Season Kick Off Party hosted by the Alaska Avalanche School.

Erik Stevens travelled the furthest to participate in the conference; he's the lone wolf providing snowpack observations to the public in Haines under the umbrella of Alaska Avalanche Information Center, a Valdez-based nonprofit that seeks to offer one-stop shopping for all things avalanche in Alaska. Erik valued most the numerous impromptu one-on-one chats with respected and experienced professionals in avalanche community. "Through these discussions I gained new partnerships, mentors, and friends," highlights Erik. "The range of perspectives of conference attendees provided incredible insight into the current state of avalanche forecasting in Alaska, and showed me exactly where my operation in Haines fits into an ongoing statewide effort."

Another grassroots avalanche information provider attending the conference was Jed Workman. Last year, Jed started to supply semi-regular avalanche conditions information for Hatcher Pass, a popular backcountry recreation spot an hour north of Anchorage. Jed also appreciated the opportunity to make in-person connections. "Alaska is a huge state. Between distance, staying busy butchering moose for dinner, and then chopping enough wood for this evening's deep freeze, I don't expect Tom Mattice from Juneau, for example, to be knocking at my door in Palmer for dinner and discussion anytime soon."



All Alaskan avalanche forecast areas were represented by the forecasting panel (l-r): David Hamre, Hoots Witsoe, Ethan Davis, Erik Stevens, Jed Workman, Kevin Wright, Tom Mattice. *Photo by Tony Henke*

After the conference, a database of all the avalanche folks in the state was compiled to improve ongoing communications. Still, meeting colleagues face-to-face at least once a year seems like a good idea.

Despite the connections made and conversations had, there is still no clear common solution on how to improve and grow avalanche forecasting in a state twice the size of Texas with sparse resources and no funding. This current debate will continue at the next regional conference – and in the many conversations between now and then.

The Alaska Snow Safety Conference was made possible with support from Alaska State Parks SnoTrac grant, American Avalanche Association, Black Diamond, Patagonia, Backcountry Access, Chugach Powder Guides, and Babes in the Backcountry. The organizing committee members were Sarah Carter from Alaska Avalanche Information Center, Debra McGhan from North America Outdoor Institute, and Eeva Latosuo from Alaska Pacific University. The organizers want to thank every presenter, participant, and volunteer for making the weekend a grand success.

Note: AAA supported the conference with a pro development grant. The grant money was used for travel stipends for Erik Haines and Jed Workman, AAA Professional Members, to attend the conference.

Eeva Latosuo is a snow science instructor at Alaska Pacific University and organizer for the new ASSC. She also deserves congratulations for becoming a AAA Certified Instructor.

top left: Christian Beckwith at his Outerlocal.com booth chats with longtime local backcountry skier Dicky Hall of Jackson at Avalanche Awareness night.

top right: Marcus Peterson of Ortovox demonstrates beacon features to a curious attendee.

right: Keynote speaker Karl Birkeland reviews final details with event sponsor Phil Leeds of Skinny Skis.

ARE YOU BEEPING?

Skinny Skis' Avalanche Awareness Night Educates 500 Jackson Hole Skiers

Story by Dan Bennett • Photos by Sava Malachowski

Perhaps your idea of safe skiing or riding in the backcountry is a morning phone call to the avalanche advisory hotline. Or maybe you are savvy enough to dig a test pit on the slope you plan to run. Wherever your level of training or ritual, you could have bumped it up a notch this December at Skinny Skis' annual Avalanche Awareness Night at Snow King Resort, Jackson, Wyoming.

Along with the usual bevy of gear giveaways, the event unveiled the latest method for accurate pit testing: a smart-phone accessible interactive map of avalanche activity in the Jackson Hole backcountry, and new trailhead checkpoints that can test whether your avalanche beacon is transmitting before you skin into the hills.

Funds Raised Benefit Avalanche Center

The evening was attended by about 500 backcountry skiers, snowboarders, and snowmobilers, and it raised nearly $10,000 from admissions, a gear raffle and silent auction. The money supports Teton County Search and Rescue and the Bridger-Teton Avalanche Center. Skinny Skis' co-owner Phil Leeds said over $12,000 in sponsor-donated ski clothing, backpacks, shovels, probes, and beacons were among the prizes. Annual ski passes to Jackson Hole Mountain Resort, Grand Targhee and Snow King were also raffled.

Local weatherman and Avalanche Awareness Night emcee Jim Woodmency always finds a creative way of silencing the audience before the guest speaker presentations. "The first thing you do when caught in an avalanche," Woodmency said, "is shut your mouth so it doesn't fill with snow. Try it now," he urged the standing-room-only crowd.

"Jim has accurately nailed his predictions on winter snowfall in the past two years," Bridger-Teton Avalanche Center forecaster Mike Rheam said. Many backcountry enthusiasts start their mornings by dialing the center's avalanche hotline. Rheam said the "avalanche event map" on the jhavalanche.org Web site has been improved to pinpoint avalanche locations, provide details on the depth and distance of slides, and give up-to-date snowpit data. Icons pinpoint slide occurrences, test pit results, and weather station locations; and clicking on the icons opens the latest detailed information. The program is based on Google Map technology and allows the backcountry user with a smart phone to verify weather and slide conditions in a particular area. The map also plots the locations of avalanche deaths.

The center welcomes receiving information on incidents and snow conditions from the public, giving the map its interactive quality, Rheam said. Avalanche Center director Bob Comey said the map was financed with money donated from Avalanche Awareness Night proceeds.

Weather & Snowpack Predictions

Woodmency predicted "a decent winter" that won't match last year's record 700"-plus. "La Niña is back, but expect it to be weaker," he said. Sea surface temperatures determine whether we experience an El Niño or La Niña effect. Cold temperatures in the Alaskan Gulf that created last year's La Niña will span a smaller area of the ocean this winter and therefore won't create as much precipitation, he explained with an entertaining PowerPoint presentation. The early and late parts of the winter will be mostly dry, he said, "but I am going to make a prediction for a fat mid-season."

Besides all the great skiing and riding enjoyment, last year's mega accumulations had another advantage. "Big snow is stable snow," Sarah Carpenter, of the American Avalanche Institute, explained. As a result, there were no avalanche deaths among local skiers in Jackson Hole last winter. Carpenter is not so optimistic about the coming season. She said sporadic fall snowstorms that did not melt in the higher elevations and on some northern aspects have created a weak faceted base. To demonstrate, she showed videos of early season pit tests that triggered instability with only the lightest tap on a shovel blade.

Dig More Pits

"If you dig under the snow you'll have a better idea of what's going on under your feet," was the most down-to-earth statement from Dr Karl Birkeland, the evening's featured speaker. A scientist with the US Forest Service National Avalanche Center, he was introduced by Woodmency as "the dirt bag who went on to earn his PhD." For a skid, his presentation was lofty.

Birkeland spoke about improvements in field testing snow conditions for better accuracy in determining unstable slopes. With slides, videos, and graphs he demonstrated the extended column test. False stability results have been reduced to 10%, and the tests also work well in low-angle terrain, he said. Birkeland urged the audience to "dig more pits" before skiing, "because snow stability can be variable over short distances."

Afterward, Birkeland's talk drew these comments: "While it was quite scientific, it may hopefully encourage some people to take their avalanche training to the next level," event organizer Sava Malachowski said.

Are You Beeping?

Even if you can spot avalanche terrain, analyze snow stability, and carry all the right equipment when venturing into the backcountry, you may have overlooked an elemental detail: Is your personal transceiver turned on and working properly?

"Are you beeping," was the question posed by valley skier and climber Christian Beckwith. This will be the winter to be certain of the answer before you start your excursion. Beckwith, who runs the Web site outerlocal.com, introduced the new Avalanche Beacon Checkpoints that will soon grace many major backcountry accesses on the pass, in the park, and at the ski resort.

The idea of checkpoints evolved after Beckwith's "bone-headedness" for failing to activate his beacon during an adventurous ski outing last winter in Grand Teton National Park. It happened on a day off from his duties as a new father, and it was a disturbing realization upon regaining the valley floor. Beckwith worked with several outdoor industry manufacturers who were eager to help develop a trailhead beacon tester. Pass within five feet of the new checkpoints and a small box will flash either a green O or a red X. The stations check the transmission of your avalanche beacon at the moment you pass, but provide no indication of your beacon's battery life or whether it will continue to operate throughout your tour.

The checkpoints will be battery operated with possible solar panel backup, Beckwith said. All equipment for the gadgets was donated by Outdoor Research and Marmot, with Backcountry Access designing and providing the electronic signal boxes. Two checkpoints have been erected on either side of Highway 22 adjacent to the parking lot, at each boundary gate at the Jackson Hole Mountain Resort, and at the Bradley-Taggart trailhead in Grand Teton National Park.

In his presentation, Teton Pass ambassador Jay Pistono mentioned the consequences of triggering an avalanche on the road that runs through the center of the popular ski destination where his job is to maintain order and civility. "If you cause a slide that results in an accident or fatality on the highway below, law enforcement will hold you accountable," he said. Pistono urged folks to exercise courtesy in the parking lot, respect snowmobile boundaries, and avoid harassing wildlife.

Dan Bennett, a former newspaper reporter and editor, is a freelance writer living in Jackson Hole. He is a mountain bike guide and enthusiastic telemark skier.

Thompson Pass Weather Station Supports Research and Forecasting

Story by Karl Birkeland & Theo Meiners

A few years ago Theo Meiners was awarded an American Avalanche Association Practitioner Research Grant. This grant was to help with Theo's mission of supporting avalanche research and technology transfer on Alaska's Thompson Pass. Since 2007 Theo has been working with a number of researchers, and their collaborations have led to several ISSW presentations, as well as articles in the ISSW proceedings, *The Avalanche Review*, and scientific journals *(Marshall et al., 2008; Birkeland et al., 2008a; 2008b; 2010; Heierli et al., 2010; 2011)*. Highlights of these collaborations include Theo's animated and well-received ISSW presentations on avalanche survival in 2008 in Whistler and 2009 in Davos.

The goal of Theo's AAA research grant was to help set up a weather station near Thompson Pass that could be utilized for ongoing research projects, as well as providing data for operational avalanche forecasting by Alaska Rendezvous Guides (ARG), other Thompson Pass heliski operators, the Valdez Avalanche Center, and the Alaska Department of Transportation. The most pressing need in the area was for ridgetop wind measurements since the only available wind data for the area was from road level. Mount Tiekel was chosen as a good site for wind due to its relative isolation from other large mountains. In addition, its close proximity to the ARG base (at mile 45 on the Richardson Highway) would facilitate access for any maintenance and repairs.

In 2009 Kelly Elder went to ARG intending to install the station, which was the same rugged design that Kelly had used successfully in many areas, including Baffin Island. Kelly constructed the mast and put the station together in Colorado before sending all the parts (and tools) up to Alaska. Unfortunately, due to a number of factors including difficulties with the satellite modem, he was unable to get it running. However, he did set the station up at the base and he crafted a comprehensive installation guide. Karl Birkeland and Ron Simenhois came up later that season intending to complete the installation, but technical problems again stalled the project.

In 2010 the plan was for Kelly to return with Ethan Greene, but their schedules and commitments wouldn't allow them to escape the lower 48. Luckily for all involved, Ron Simenhois was able to get some time away from his job forecasting avalanches for an Alaskan mining operation so he could work on the site. Crane Johnson (the weather station guru for the Friends of the Chugach National Forest Avalanche Information Center) helped Ron out and did the programming for the satellite data link. With this support from Crane and lots of assistance from the ARG guides and staff, Ron was able to get the site fully functional at the base. Then, with the help of a crew of hardy ARG guides – Nick Houfek, Dan Janjigian, and Mike Trombetta – the station was lifted up to Mount Tiekel and installed in brutally cold subzero temperatures with strong winds *(see photo, above right)*.

Since its installation, the site has churned out wind, temperature, and relative humidity data. In addition to the avalanche operations noted above, the site was also used last spring by the National Weather Service hydrological forecasters since high-elevation sites such as these are rare in Alaska. During a large storm in November 2011 the wind sensor stopped working, but within a week it kicked back to life – we are guessing it must have gotten blown clear of either rime or snow. The site still hasn't made it all the way through a harsh Alaska winter, but so far we are cautiously optimistic!

Alaska Rendezvous Guides installing the station on Mount Tiekel. Skies were clear, but winds were blustery and temperatures were well below zero. *Photo by Ron Simenhois*

The data are freely available to the public both through the Friends of the Chugach National Forest Avalanche Information Center *(www.cnfaic.org/wx/wx_caic.php)* and through the Colorado Avalanche Information Center *(avalanche.state.co.us/obs_stns/zones.php?area=Alaska)*.

Acknowledgements

A big thanks to AAA for partially supporting this project through a practitioner research grant. This project required the cooperation of a large group of folks including Alaska Rendezvous Guides (Theo Meiners and his staff and guide crew), the US Forest Service National Avalanche Center (Karl Birkeland) and Rocky Mountain Research Station (Kelly Elder), the Colorado Avalanche Information Center (Ethan Greene), Boise State University (HP Marshall), the Friends of the Chugach National Forest Avalanche Information Center (Crane Johnson), and Ron Simenhois. The Bureau of Land Management graciously allows the use of the site.

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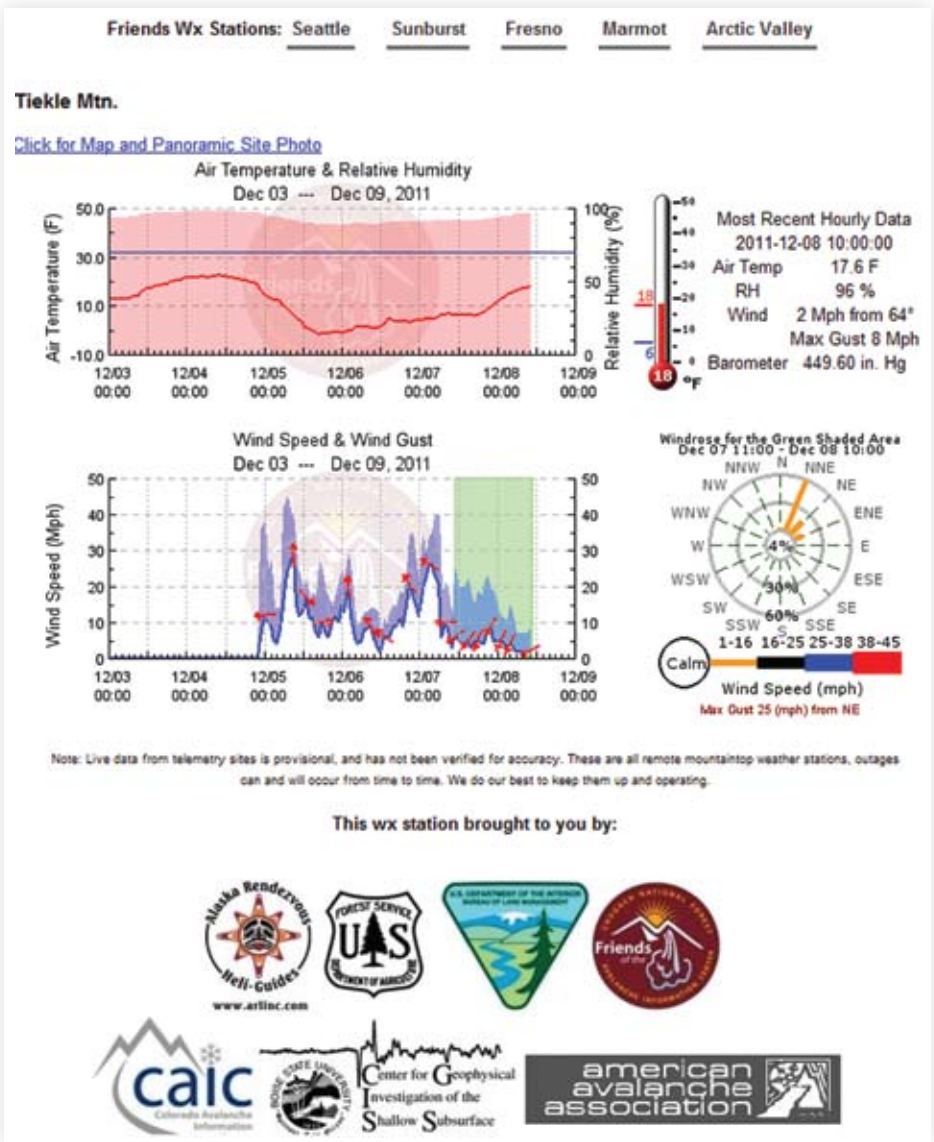


Screenshot of weather station data from the Friends of the Chugach National Forest Avalanche Information Center Web site. The authors thank Crane Johnson for setting this up.

Northwest Snow and Avalanche Summit Continues to Educate and Inspire

Story by Dan Kostrewski • Photos by Don Svela

When I first started teaching field sessions and beacon search at the Mt Baker Mountain Education Center, the prevailing view toward avalanche education was similar to earning a high school diploma. Once a skier or rider earned a level one or level two card, the concept of diving back into subjects such as pit study or human factors was treated with the same excitement and urgency as revisiting algebra, economics, or biology.

At the same time, many volunteer educators, ski patrollers, and high-level recreational skiers and riders in the Pacific Northwest viewed avalanche awareness as a static subject. Passing the courses and completing the required reading list were seen as a conclusion on a path to awareness, whereas continuing education in a constantly evolving field was treated as a low priority within a high-risk population. And for volunteer educators, semi-pro riders, or hourly-wage patrollers – who all fit somewhere just beneath the ISSW level on the occupational hierarchy – very few opportunities existed to shift the paradigm.

But the Northwest Snow and Avalanche Summit (NSAS) changed all that, creating a mindshift for Cascadian backcountry skiers that range from Mt Baker to Crystal Mountain. Starting five years ago at the urging of the American Avalanche Association, Education Committee member Michael Jackson drew on his professional connections and his advanced educator background to skim from the cream of the avalanche professional crop and entice cultural heros into presenting what they know. The highly skilled and highly memorable speakers have ranged from Dale Atkins of AAA and Patty Morrison from Stevens Pass ski area to ski mountaineers Lowell Skoog and Sky Sjue. But what really turned the NSAS from another piece of required coursework into an annual rite for a regional brotherhood of educators, patrollers, and professional athletes was not just the depth and breath of the topics, but that the event blended the insightfulness of a professional symposium with the feel of a festive pre-season gathering. And, of course, the smoked salmon and free post-presentation beer from official sponsor New Belgium Brewery didn't hurt the cause.

The 2011 NSAS did not disappoint. Once again hosted by REI in its flagship Seattle store, the November event kicked off on a somber note by recognizing the tragic passing of well-loved Washington skier and educator Monika Johnson by introducing the scholarship fund that will carry her name. Awards of lifetime recognition were presented to Frank Rossi from the Summit at Snoqualmie and to avalanche research and guiding legend Rod Newcomb, who took the microphone and PowerPoint controls as the event's first speaker.

Newcomb provided a historical recollection that traced back to the early American roots of the avalanche safety, control, and forecasting profession. With first-hand accounts and personal photographs of his work with Monty Atwater, Ed LaChapelle, and Ron Perla, he blended facts and history with colorful stories tied to the early decades of Alta, the founding of the National Avalanche School, and his work with the San Juan Avalanche Project. His timeline, which ran from the 1940s to the 1970s, provided historical insight into three founding decades of the profession.

Garth Ferber, of the Northwest Weather and Avalanche Center, changed topical course and provided a deep dive into the detailed operation, data interpretation, and maintenance effort required for 40 NWAC weather stations to operate throughout the region. Exploring the idea of "Fact or Fiction," he provided a detailed account of how to determine the accuracy of hourly weather station data, which has become a critical forecasting tool – and virtual replacement for official ski area snow reports – for skiers throughout the Northwest. NWAC receives a ton of regional grief for stations that malfunction or don't report accurate data, but understanding the totality of the effort required will give any skier pause before complaining that the total snow gauge is off when checking remote data from the comfort of home.

Karl Klassen, the Canadian Avalanche Centre director of forecasting, then tackled the topic of a "Structured Approach for Public Safety Products." In addition to evoking regional envy for the advanced nationalized state of the Canadian avalanche effort, his presentation highlighted how far the Canadians have progressed in formalizing risk management tools for recreational skiers through an interaction of the Public Forecast, the Avaluator, and terrain-mapping tools that integrate professional mapping with Google Earth.

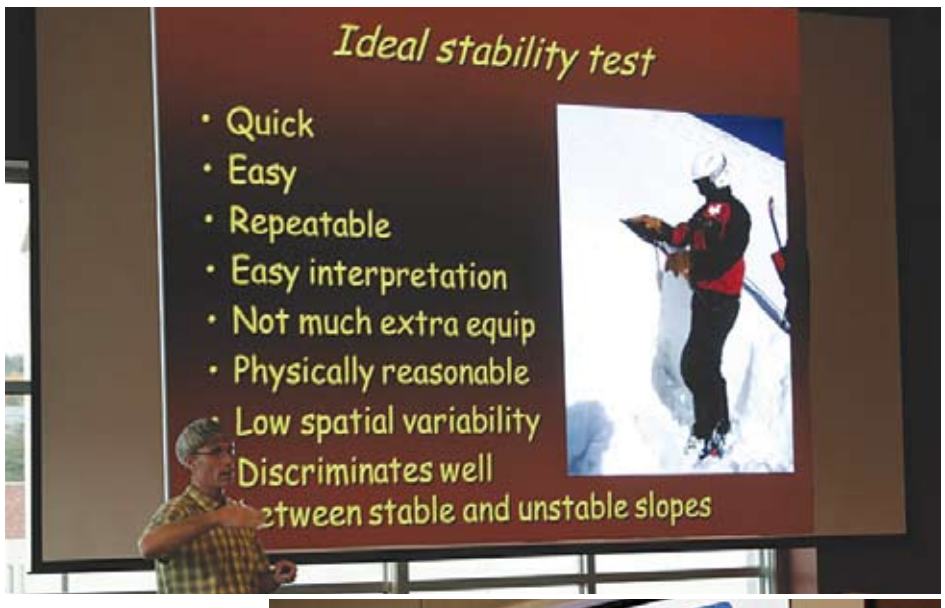
The Canadian model provided structure and interconnectedness for every element of public avalanche education. Efforts begin with using consistent and tiered information and graphical iconography in the public forecast. Forecasters and readers alike are trained to understand tour ratings and hazard-level connected recommendations. Emerging technology is used to craft clearer tools for decision-making for all levels of users in simple, challenging, and complex terrain.

Klassen also demonstrated the potential of drilling down terrain ratings to the individual tour scale for a huge database of popular routes, but acknowledged that expanding this database was a mammoth undertaking.

"Scaling is a complex problem," summarized Klassen. "Anyone who has been in the business for a long time knows it's all judgment, it's all subjective, all the time."

The Canadian effort was an inspiring model; however, any thoughts of regional duplication were cut short by Klassen's sobering stat that the CAC initiative required $250,000 in public and private funding from sources such as the provincial British Columbia government to accomplish. And, in a region that struggles to keep a three-person forecasting center funded, that financial reality seems out of reach.

The NSAS continued its convention of featuring unconventional speakers when Mike Richardson dove into the expansive topic of how psychological factors interact with risk management, decision-making, and backcountry safety. Keeping up with Richardson's theories and threads requires intense mental focus, but one of his many themes was the simplification of the complexities of psychology, risk management, science, and ski mountaineering. His DUST matrix of desire,



above: Karl Birkeland makes the rounds during workshop season, helping the masses make better decisions.

right: Karl Klassen comes down from the Canadian Avalanche Centre to introduce the Yanks to their array of public forecasting products.

uncertainty, stress, and trouble paired with topics such as communication models, observation prioritization, and acknowledgement of uncertainty provided plenty of material to digest in an area of awareness that often gets little attention. "Normal uncertainty should not cause undue anxiety," summarized Richardson. "When we acknowledge, identify, and reduce uncertainty we can make safer decisions."

Oyvind Henningson, of Snohomish Country Search and Rescue, began his presentation with a risk and consequences overview from an SAR perspective. He detailed the logistics and human hours required for the rescue response and progressed to a case study of the successful April 6 rescue on Mt Snoqualmie where three skiers were caught in a slide: two were injured, and an extensive 95-person rescue effort was launched to extract them to safety. The most memorable aspects of his presentation were listening to the chilling 911 call and the first-hand account of the logistics, time, and factors required to successfully extract an injured party from a backcountry avalanche incident.

Karl Birkeland, director of the National Avalanche Center and a professor at Montana State University, spoke about recent developments related to spatial variability through an extensive analysis of correlation rates between micro-slope stability and the new extended column test. Highlighting a holistic approach to targeted instability tests, his studies and slides reemphasized the constantly changing landscape of slope instability testing.

Zach Guy, from Montana State Department of Earth Sciences, also presented very interesting scientific findings about the potential trigger locations specifically related to steep couloir and cirque skiing. Conducted at Big Sky and in Jackson Hole, his in-the-field research homed in on micro-terrain factors such as elevation, distance from edge, wind index, and exposure that have the highest impacts on shifting the stability of extreme terrain.

Guy's effort was clearly time intensive, and it is one that deserves much more funding, attention, and detailed study in the future. Few skiers or riders in the young, high-risk, backcountry demographic seek out 30-degree slopes to shred, yet few study efforts have focused on steep, freeride terrain.

The presentations concluded with an inspirational image gallery from climber and aerial photographer John Scurlock, whose stunning image galleries have inspired a new explosion in remote ski-mountaineering trips throughout the North Cascades during the past five years. It was a fitting way to end another NSAS, with a virtual flight into the massive Cascadian peaks that inspire everyone in the audience and bring us all together in an effort unlock their mystery and stay safe in the process.

Once again, the event would not have been possible without the assistance of sponsors such as Outdoor Research, AIARE, Pro Guiding, Backcountry Access, AAA and New Belgium Brewing. And a huge high five of recognition goes out to event moderator Steve Christie, who kept the interludes entertaining, and to Michael Jackson and the NSAS volunteers, who not only created a new source of continuing education but also shifted a regional attitude in the professional ranks about the need to stay sharp as the social science of avalanche education and awareness continues to evolve.

Dan Kostrewski is a Washington-based freelance writer who graciously donated his time to write this article about the NSAS.

First Annual Eastern Snow & Avalanche Workshop Wows Capacity Crowd

Story by Jonathan S. Shefftz

- ❒ ***Snow?*** Check.
- ❒ ***Mountains with above-treeline terrain?*** Check.
- ❒ ***Avalanches?*** Check.
- ❒ ***Avalanche fatalities?*** Check (unfortunately).
- ❒ ***USFS forecast center?*** Check.
- ❒ ***Avalanche safety courses affiliated with NSP, AIARE, AAA, and even CAA?*** Check.
- ❒ ***Professional AMGA mountain guides?*** Check.
- ❒ ***Multi-agency and volunteer SAR teams?*** Check.

So what's missing from this picture of the northeastern avalanche scene? Despite all the essential ingredients, we have never held a one-day regional version of an ISSW, though such events are popular in other regions of the country with avalanche terrain.

That situation was corrected this year by the collaborative efforts of USFS Mount Washington Avalanche Center Lead Snow Ranger Chris Joosen and AAA Eastern Representative Kyle Tyler. The first Eastern Snow & Avalanche Workshop (ESAW) was held November 5 in North Conway, New Hampshire, at our generous host facility, the Mount Washington Observatory Weather Discovery Center.

Such a continuing education and community-building event certainly had strong demand, as half the initially planned 75 attendee limit was reached within a few hours of an email announcement, and the event capacity was met only five days later. The final tally was 85 attendees, with about half again that many on the wait list. The $45 registration fee was supplemented by a $500 grant from the American Avalanche Association, and proceeds over and above the hosting costs went to the White Mountain Avalanche Education Fund to educate children in the northeast about avalanches.

top: The gear raffle, held post-event at International Mountain Equipment, raised money for youth avalanche education.

above: Mammut rep Eric Siefer sets up his son Cole with the Mammut airbag pack. *Photos by David Lottman*

Like similar workshops, presentations appealed to a mix of snow professionals and enthusiastic recreationists. Chris Joosen kicked off the event with a discussion of spatial variability in NH's direct-action avalanche regime. Our avalanche climate is best characterized as Arctic maritime: very high winds (such as the longtime record-holding 231mph gust in1934) scour broad, above-treeline fetch zones to load steep glacial cirques. Deeply buried instabilities are rare (and often quickly "paved over" by brutal thaw-refreeze events), while only several meters can separate deadly wind slab from no snow at all.

Next was Jim Giglinto, a New York state forest ranger for the Department of Environmental Conservation in the Adirondack High Peaks. Although almost entirely below treeline, the 'Dacks have very thin soil, and hence are prone to massive summertime landslides down to bedrock. These paths offer excellent backcountry skiing routes – with 16 more recently created by Hurricane Irene's 13" of rain – but also allow for wintertime snow avalanches.

With the geographic stage set, three heavy duty snow-science presentations ensued: propagation propensity of persistent weak layers by Kyle Tyler (who studied snow science at Montana State University with some of the field's iconic figures), upslope snow development and effects by Rebecca Scholand (a Mount Washington Observatory meteorologist who was brave enough to confess to this gathering that she doesn't care about snow after it falls on the ground!), and snow physics by Sam Colbeck (retired from the US Army's Cold Region Research and Engineering Laboratory after three decades of groundbreaking cold lab research in snow-crystal bonding).

Joosen lightened the tone with a presentation on social media and other human factors involved in avalanches in the northeast (including Facebook-triggered rescues). After the final of the four raffles from our many sponsors (including 10 TAR subscriptions), Mammut representative Eric Siefer showed off the latest in avalanche safety technology, including a deployment of the new Mammut airbag pack. Your faithful correspondent wrapped up the event with a version of his April 2011 TAR article on assigning pre-course homework to Level 1 students. Afterward, ESAW adjourned down the street to our second host, International Mountain Equipment, for socializing, vendor displays, and a BCA airbag pack deployment.

With strong attendance, strong presenters, and a strong sense of community development, the only complaint was that we should have held ESAW in prior years! But we all look forward to continuing our new annual tradition.

```
Hi All – ESAW is over – Success!

85 folks registered and attended –
turned away 40.

Broad spectrum of great talks.

Stayed on schedule to the min – lucky??

Gave out a lot of raffles, including 10
subscriptions to TAR!! and 7 copies of
SWAG – reinvesting.

Outstanding positive response from all
about the program. Great questions from
the attendees.

Sam Colbeck repeated his 2000 ISSW talk
about Sintering of Unequal Grains in
Snow. Sam has agreed to be filmed at
CRREL in Hanover; he will repeat that
talk – our copy of him at ESAW didn't
come out good enough to send out.

Plenty of beer and vendors at the social.

Thanks to all for the AAA grant – will
send out an expense report.
```

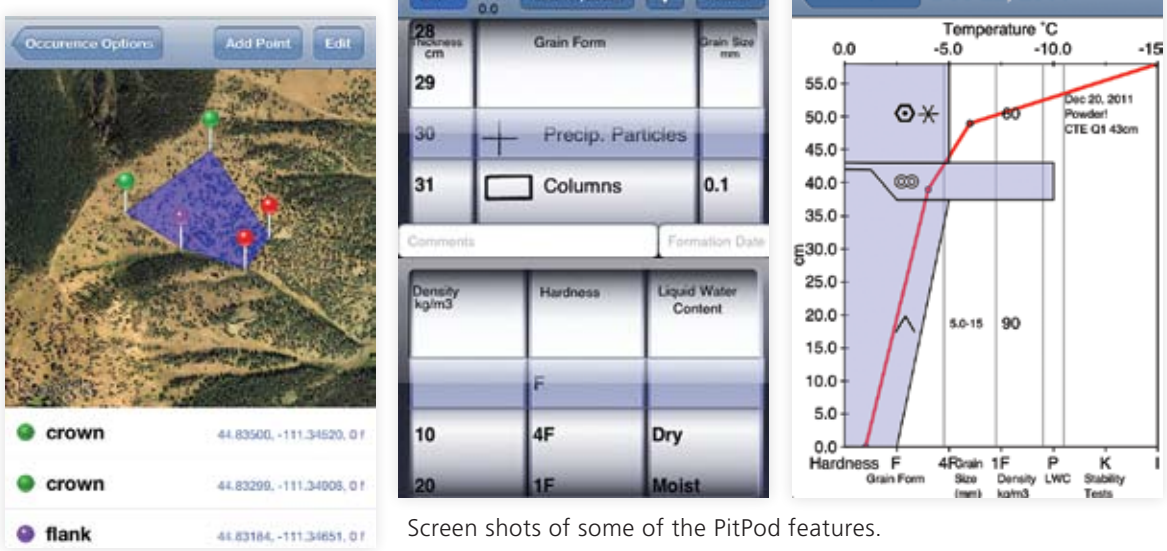
Kyle Tyler is the Eastern Rep to the AAA board and one of the ESAW organizers. Congratulations to him and all the hardworking organizers on a great first year. ❄

Jonathan Shefftz lives with his wife and mondopoint-size-13 daughter (still too small for "Tech"-compatible ski touring boots) in western Massachusetts, where he patrols at Northfield Mountain and Mount Greylock. He is an AIARE-qualified instructor, NSP avalanche instructor, and AAA affiliate member. When not searching out elusive freshies in southern New England, he works as a financial economics consultant and has been qualified as an expert witness in federal agency Administrative Court, US District Court, and state courts. He can be reached at jshefftz@post.harvard.edu. ❄

PitPod: Another New Snow App for iPhone

Imagine… You see an avalanche, ski over to the crown, and pull out your iPhone. Snap a photo, measure the slope angle and aspect, then record a crown profile – all on your phone. While descending the path, use your phone as GPS to map the slide. At the toe of the slide send a diagram of the crown and a map of the slide to colleagues back at the office, then post it on Facebook to alert the public. With PitPod you can do all that and more, plus it's free.

PitPod, a new iPhone and iPod touch application for recording snowpits and avalanches, is now available for free on the iTunes store. PitPod is a digital snow and avalanche field book. The app was developed to easily enter snow and avalanche data in the field, then electronically share that data. PitPod uses all those fancy features on your iPhone to make this as easy as possible. It has all the features an avalanche professional would want, yet it is simple enough to be used by backcountry skiers – even snowboarders.



Screen shots of some of the PitPod features.

PitPod can be configured in different modes for varying amounts of data collection. In scientist mode it supports all the fields in SWAG, with all the grain types and sub-types, and metric units. In basic mode it only asks for the most essential weather data, and features just the major grain types and US units. It can be configured anywhere in between these two extremes.

PitPod includes clinometer, GPS, and compass support so you can accurately measure and mark your field sites. PitPod is designed to be used in the field; there is no need for a WiFi or cell signal. Most inputs are multiple choice to eliminate the need for typing, and the buttons are big for use with cold fingers.

PitPod produces professional quality snowpit diagrams in the standard format as well as a compact format for display on mobile devices, and it saves diagrams as an image or PDF file. Other export formats include KML maps of avalanches, CAAML xml, and SnowPilot format. PitPod can upload to Facebook, and it can even print. PitPod can also import CAAML v5 snow profiles so you can load data from other software for viewing in the field.

For more information see PitPod.net or search for PitPod on the iTunes App store. Contact: Jesse Crocker, Jesse@PitPod.net, 707-292-4042. ❄

Colorado Snow and Avalanche Workshop Celebrates Ten Years

Story by Scott Toepfer

Weather forecaster Joe Ramey makes his annual appearance at CSAW; the rest of this year's lineup was just as skilled and slick as Joe.

This year was a milestone for the Colorado Avalanche Information Center as we celebrated the tenth anniversary of the Colorado Snow and Avalanche Workshop (CSAW). I'm not sure that 10 years ago we had any idea how successful this workshop would become. In 10 years CSAW has grown from about 50 people gathered in a local ski area's back room to a crowd of over 450 at the National Mining Hall of Fame Conference Center in Leadville. If CSAW grows much bigger, we'll have to find a new venue and bring in professional event planners.

To mark CSAW's tenth anniversary, we invited speakers from around the United States to as far off as Switzerland. Dr Jürg Schweitzer, director of the WSL Institute for Snow and Avalanche Research SLF (WSL-SLF), gave two presentations. Jürg delivered two excellent talks – one on fracture mechanics and propagation and the other on a history of the WSL-SLF. Several members of the CAIC staff were impressed with the cutting edge soft goods of the 1930s and '40s worn by the forecasters: tweed jackets, ties, and even tobacco pipes while doing full data pits. This old-school apparel certainly cast a suave and sophisticated air compared to today's Gore-Tex and duct tape-clad forecaster. There is no doubt the local television stations would enjoy the spectacle of an avalanche forecaster, in the field, wearing a suit and tie and smoking a pipe while discussing the properties of anti-cracks. We may need to approach the new breed of clothing designers and see what they can come up with for our next dress code.

Jürg Schweitzer makes a point about incorporating a variety of factors into stability assessment.

Jordy Hendrikx from the Earth Sciences Department at Montana State University made the trip south to discuss the relationship between snowpack tests and spatial variability. There is a broad array of snowpit tests available to today's practitioner, and Jordy discussed the pros and cons of these tests and how they fit in with our current understanding of variability within the snowpack.

AAA President Dale Atkins gave an animated presentation on the history of Colorado avalanches.

Dale Atkins, of Recco International and president of the American Avalanche Association, gave a lively talk on the history of avalanches in Colorado beginning in the 1860s. We may never see the carnage from the late 1800s again when miners wandered willy-nilly across the Rocky Mountains. We can only hope that today's avalanche worker will be able to protect the assets entrusted to them.

Pat Ahern of Telluride shows off some of his fancy toys to the crowd.

Pat Ahern, Telluride Ski Resort, spoke about a remote-controlled roller they use in some of their avalanche-prone areas. This roller could be a functional and cost-effective tool to compact areas traditionally boot packed. Telluride is known for its deep-slab problems had lingered well into spring, past when most avalanche centers had closed for the season.

Finally, Halsted Morris with the AAA Awards Committee presented Ian Borgeson with the Bernie Kingery Award in honor of his father, Leif, who died while climbing Highlands Bowl at Aspen last winter. Leif Borgeson was a character larger than life in our Colorado avalanche community, and his smile and powerful handshake will be missed by everyone who ever knew him.

depth hoar problem, and this mechanized-age hardening machine looks to help manage the problem.

Pat's talk led to the always popular look at the winter's prognosis by Joe Ramey with the National Weather Service in Grand Junction. As we all know, another La Niña is established over the Pacific Ocean. ENSO events are common tools for looking at long-range forecasts, but two La Niñas in a row open the door to some speculation, as these back-to-back patterns are not common. Add to that a changing climate, and the long-range forecast gets tricky. Joe's take-home was that we will probably see a normal winter across much of Colorado, with areas favored by northwest flow doing better than average, and our southern zones generally suffering between big events. It all points to another potentially dangerous year for avalanches across Colorado.

Joe's talk brought us to the mid-day break, and then the always tough first presentation after lunch. This difficult time slot fell to Don Sharaf who discussed a practitioner's view of crack propagation. Don has worked in a number of avalanche climates, and his job as a guide has given him many opportunities to think about this critical factor in the decision-making process of safe backcountry travel. Don's presentation gave attendees plenty of food for thought.

John Snook, CAIC forecaster, gave an engaging talk on some new weather forecasting tools the center began to develop this past summer. John's skills at computer programming and weather forecasting offer some potentially wonderful improvements in the CAIC's weather forecasting skills. We now have our own "Super Computer" which we can use to run the WRF regional-scale weather model. The potential for the new forecasts looks really exciting.

The final presentation of the day, by Scott Toepfer and Sara Simonson, examined common issues and problems involved with rating the size of avalanches. On April 29, 2011, a large and destructive avalanche released naturally near the Continental Divide in central Colorado. In addition to destroying numerous old-growth trees, this avalanche also pretzeled a 100,000 volt electrical transmission tower. Although tree ring analysis has not been completed, it looks like some of the trees destroyed in this avalanche were more than 300 years old. It was an impressive event not just for its destructive component, but also because Colorado's

CAIC forecaster Scott Toepfer tells attendees that the trees an avalanche knocked over were "this big," as co-author Sara Simonson looks on.

Brad Sawtell is honored by the CAIC with the gift of a framed photo for his years of service as Summit County forecaster.

CAIC forecaster Scott Toepfer (see photos above) continues to organize the CSAW event and write it up for TAR; at this point his event-planning skills could command big bucks in the private-sector market.

crown profiles

above: Jamie and his partner remotely triggered this slide, 2' deep and 600' wide, mid-Cirque of Peruvian Gulch at Snowbird. It then covered their boot pack.
Photo courtesy Utah Avalanche Center

Madness in the Mountains

Story by Drew Hardesty

November 13 this year was a day we are all still trying to understand. Maybe by writing about it, we start to learn a few things…

It was madness. But I didn't know its full extent until I was in the thick of it myself. The wheels of the 747 had just hit the tarmac. It was November 13. I was just returning from a quick climbing trip to Red Rocks when I discovered the Twitter feed by colleague Brett Kobernik (of the Utah Avalanche Center) waiting for me on the iPhone.

> First human-triggered slide just reported, 12" deep, 9600' – north, remotely triggered.

> Sketchy details reported on second skier-triggered slab avalanche, Gunsight, Alta. Injuries reported.

> Likely no one caught in third slide. Fourth skier-triggered slide just reported, no one caught.

> Alta Snow Safety closing area to uphill travel.

> Yet another avalanche; two caught in Little Chute (Mt Baldy), lost some skis, no injuries.

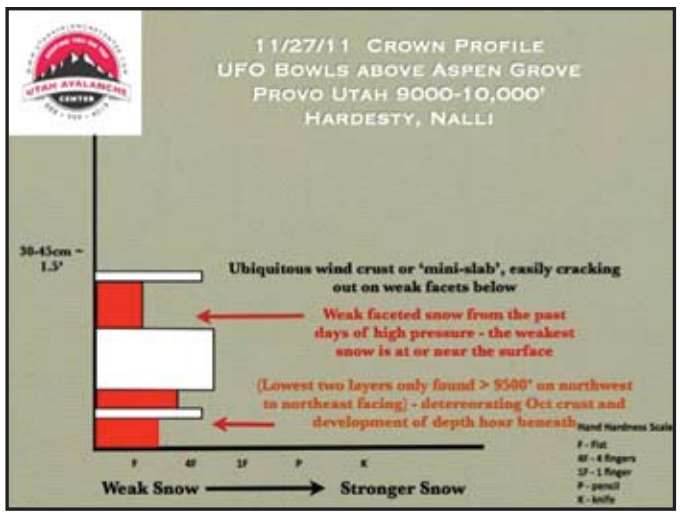
I hadn't gotten off the plane before I called Kobernik at the UAC office. There was no question – we had to go to Little Cottonwood Canyon to have a look for ourselves. It was 2pm.

La Niña had skunked us for most of October and November, and now 14"/1.75" SWE had just walloped our thin and nearly rotten-to-the-core "base." Kobernik's forecast that morning: "The avalanche danger is a solid CONSIDERABLE in terrain above 9500' on northwest- through east-facing slopes. It could easily go to HIGH danger in the Cottonwoods if we see heavy snowfall this morning. Make no doubt that conditions are ripe for someone to get caught in an avalanche."

An hour later we were talking with some of the Alta Snow Safety crew: Titus, Howie, Grom, Damian. They had closed the area to uphill traffic only 90 minutes before. (Snowbird had been closed to uphill traffic from the day before – neither resort had yet opened for the season.) Grom (Dave Richards) had just returned from rescuing a skier who had fractured his femur from the slide in Gunsight. Things were not good. He and his team arrived to assess the scene from below in order to access and package the patient. The problem was the open terrain – and other potential triggers – above.

What happened next is inexcusable. Beyond so. The other parties on the ridge skied down, triggering more slides adjacent to the scene. Few realize the risks that rescuers assume to assist others, and it was luck that Dave's Wasatch Backcountry Rescue team was only dusted, not hit. I maintain that this type of event, or sequence of events would not have happened had it been outside of the ski area boundary. Move the crowds up and over the Cottonwood ridgeline to the north, and everyone likely would have been on their Ps and Qs.

Continued on page 22 ➡



left: Structure of a crown profile from Provo Canyon, similar to the snowpack in Little Cottonwood Canyon two weeks previous.

From Tom Kimbrough

For years we have been trying to keep people from triggering/getting caught in avalanches. Now, for the better riders, that is not the issue.

I think the ski area complacency problem wasn't a factor for the better riders out there. All of the very good riders out there that day knew they were going to trigger avalanches. This goes especially for the fatality. I suspect they saw slides triggered before they left Alta. I suspect they were aware of the slide in the Cirque.

So "look for signs," "the unopened resort is just like the backcountry," "ALPTruth," etc, isn't the answer for the present-day good riders. Look at the slide Paul [Kimbrough] triggers at Baker in the latest movie. I talked with him about that day. They were entirely aware of the avalanche problems that day. Their discussion of the conditions was about how to manage the slides that they knew they were going to trigger.

When Jaime drops in he is fully aware that the slope is going to release. He expects to be able to "manage" the resulting avalanche. And he is not far from wrong. What can a good rider expect to "manage?" The slides aren't breaking deep. It is mostly a new snow problem. It isn't a hard slab. It isn't a wind slab. New snow, shallow soft slabs, easy to manage – they had handled those conditions many times without any trouble.

What went wrong? When the slab broke it lost cohesion, and Jamie sank in down to the rocks and couldn't ride out of it.

I have heard people recognize this in a way, saying that if it was February and the snowpack was deep, he could have taken the ride and probably been OK. That is true, but if it had been February he wouldn't have taken the ride at all. He would have "managed" the slide, getting off to the side if it had broken early or straightlined out if it had broken late.

That's my take. TK

Tom Kimbrough has retired from prior careers as forecaster at the Utah Avalanche Center and Jenny Lake climbing ranger in the Tetons. He still teaches avalanche courses in the Wasatch and pays close attention to stability questions.

IRWIN: A New Snowcat Operation with the Same Old Deep Snow

Story by Billy Rankin

If you haven't heard by now, there is a new snowcat ski operation outside of Crested Butte, CO. Irwin reopened commercial operations 12 miles west of Crested Butte for the 2010/11 season under new management and is a continuation of a long-time skiing legacy. Irwin Lodge was built in 1977 and was a snowcat ski operation for many years through the '80s and '90s before closing down in 2002. Irwin has always been known for a unique microclimate that produces an abundance of snow by benefitting from most weather patterns from north through west though southwest. This small operation boasts elegant amenities but also 738" of snow during the 2010/11 ski season, which stopped measuring on April 22.

WINTER SNOW TOTALS	2009/10	2010/11
OCT	30"	39"
NOV	23"	100"
DEC	122"	138"
JAN	67"	86"
FEB	127"	137"
MAR	59"	134"
APR	97"	104"
TOTAL	525"	738"

Based on measurements taken from mid-October to April 22.

Irwin's Weather

Irwin is perched on the western edge of the Elk Mountains above Lake Irwin on the southern end of the Ruby Range. This location is geographically blessed by its exposure to the west with very few mountain barriers. Like Crested Butte, Irwin does best under the straight westerly or zonal flow. Any moisture that makes it through the Wasatch Mountains cruises west across the Utah desert, travels over the Uncompahgre highlands, gets lifted by the Ruby Range, and dumps on Irwin. Crested Butte relies on strong zonal flow for its productive snowfall, as that is what it takes to push the moisture past the Ruby Range. During weak zonal flows or SW and NW flows Crested Butte sits in the rain shadow of Irwin. Many days one can look west from Crested Butte and see the line of clouds just west of town. Irwin does well under the SW flow as moisture slides just to the north of the San Juan Mountains and again gets lifted by the Ruby Range.

The NW flow storms also favor Irwin, as they come over the Raggeds and get good lift before wringing out the moisture over Irwin. On a somewhat typical open wave trough, Irwin will receive snow throughout the entire storm. It begins with the warm SW flow, when the snow begins an entire day or two before Crested. Then as the trough begins to pass we get intense snowfall with the cold front passage when Crested Butte receives snow. Then on the backside of the trough we will get the colder NW flow orographics for another day or two before it is all over. This also helps stack the snow in a favorable right-side-up configuration. We typically get two to three times the amount of snow that Crested Butte receives – with Irwin just 10 miles west of Crested Butte.

What Else Makes Irwin Unique

Irwin has over 1000 acres of terrain with east, south, and west aspects between 10,000-12,200' in elevation – and yes, that's correct, no north-facing terrain. With three different aspects we see great variety and variability in our snowpack structure and stability, which keeps things interesting. We deal with a lot of persistent crust layers and near-crust faceting. About 50% of our terrain is steep avalanche-prone terrain. We usually have an Intermountain-type snowpack, as far as the depth goes, with continental-type basal layers.

We have a very in-depth snow-safety program. We conduct avalanche hazard forecasts and evaluations daily, and we try to get at least one full profile a week from each of our aspects. We utilize Powdercloud, an online database: www.powdercloud.com. We use explosives to help assess and mitigate our avalanche hazards. We use ski and bootpackers early season to stomp around our avalanche start zones. We have a world-class guide staff with a good mix of guiding and ski patrol backgrounds.

We maintain two weather stations: one at our study plot at 10,400' and another on Scarp Ridge at 12,000'. We get great wind data from Scarp Ridge; it is a valuable wind site for backcountry users in the Crested Butte area. See data at www.wxstns.net/wxstns/grandnet/CS_IRWIN_LODGE.html

To see current snowfall history, weather data, and webcam images go to the Irwin Web site at: www.irwincolorado.com/winter#/snow-report/summary

Billy Rankin is snow safety director and chief guide at CS Irwin.

12/18/10 STORM RESULTS

Like many areas in Colorado the December 18, 2010, storm was memorable. We received 67" of snow and 7" of water in six days, and we saw some uncharacteristic size 3 avalanche releases, documented at right.

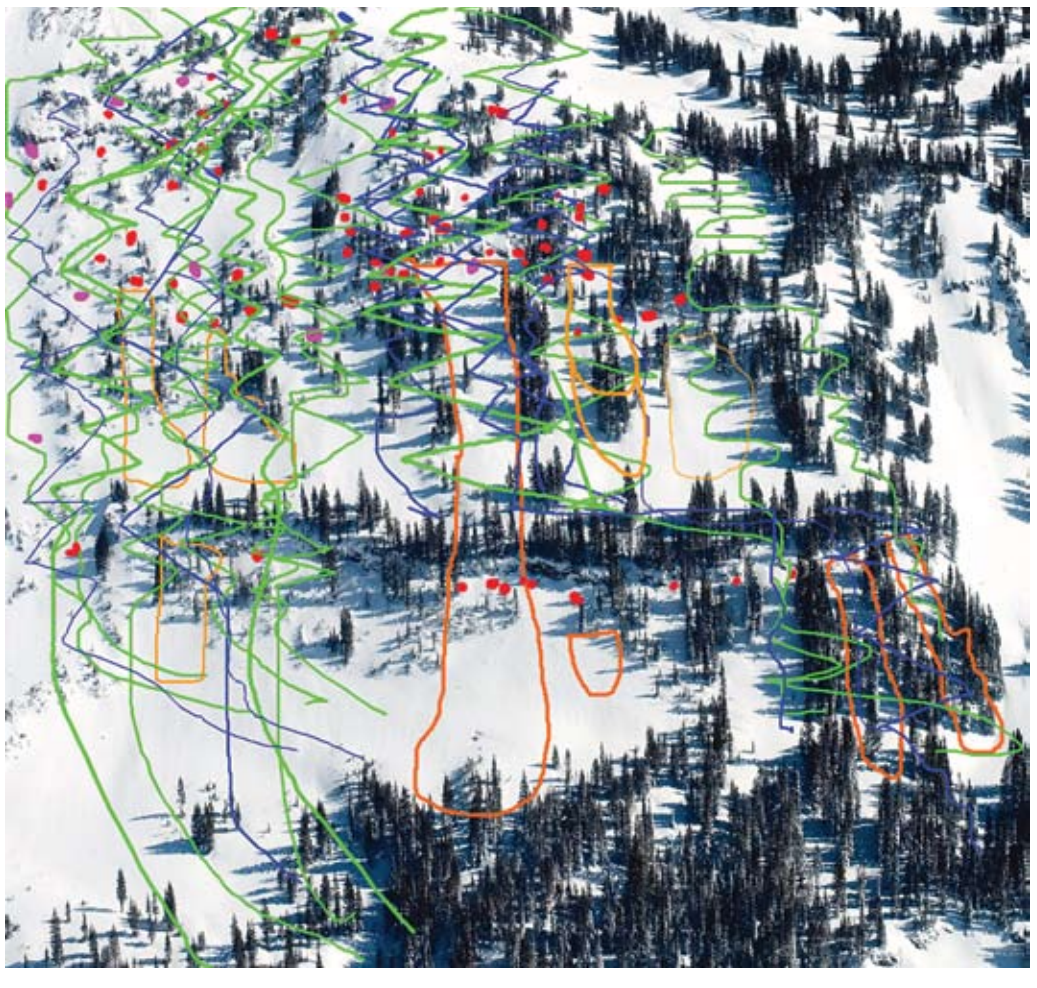
In all pictures:
Red dots ..... 3lb Shots
Purple Dots... Air Blasts
Orange..... Avalanches
Blue ..... Ski Cuts
Green..... Ski & Boot Packing

DECEMBER 21, 2010

W, 11,450', 39 degrees, Outer Limits: HS-AEr-R5-D3-O/G
Dimensions: 160cm deep, 230' wide, 1000' down
Snow: HN24: 18" w/ 2.2" water, HST: 31", HS: 64"
Danger: High
Trigger: 3lb shot low in OL Glades 100' and below crown. Debris went through Round 2 into the flats. One sympathetic in Widowmaker: 4' crown, 40' wide. The top of this slope and around the rock band had been ski & boot packed.

Day of Slide

Cumulative Work in December



above: The CS Irwin trail map invites the reader up the cat tracks and down the runs.

left: Party Hats goes big with a 3# air blast. *Photo by Billy Rankin*

DECEMBER 21, 2010

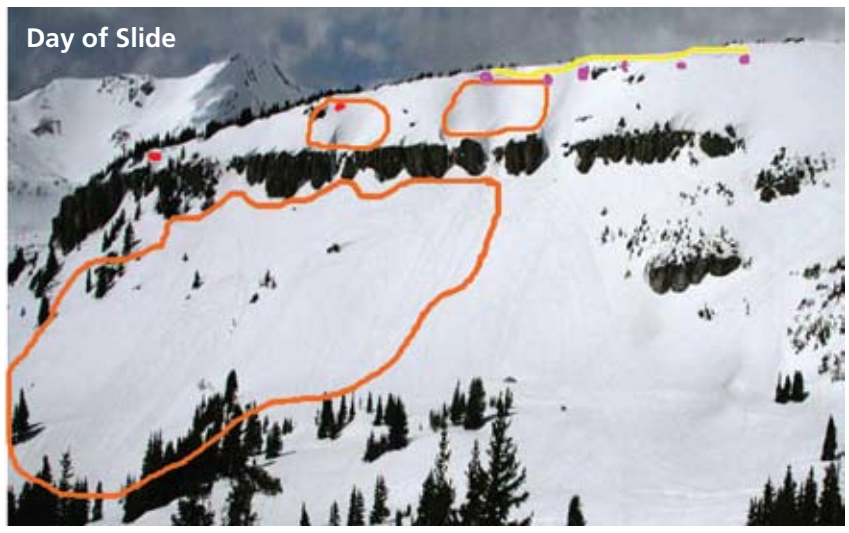
SE, 11,900', 40 degrees. Sonic to Thin Line, HS-AE-R3-D3-O

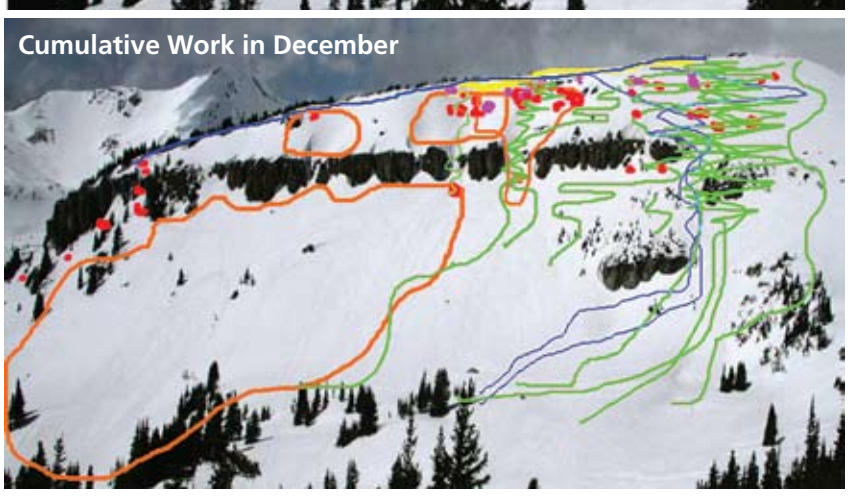
Dimensions: 120cm deep, 650' wide, 800' down,
Snow: HN24: 18" w/ 2.2" water, HST: 31", HS: 64"
Danger: High
Trigger: Detcord and shots across ridgeline. The slide propagated from Sonic all the way to Thin Line and pulled out significantly in the apron below the cliff band. Initiated just to the right of where packing efforts stopped.

DECEMBER 22, 2010

West, 11,500', 44 degrees, Party Hats: HS-AE-R4-D3-O

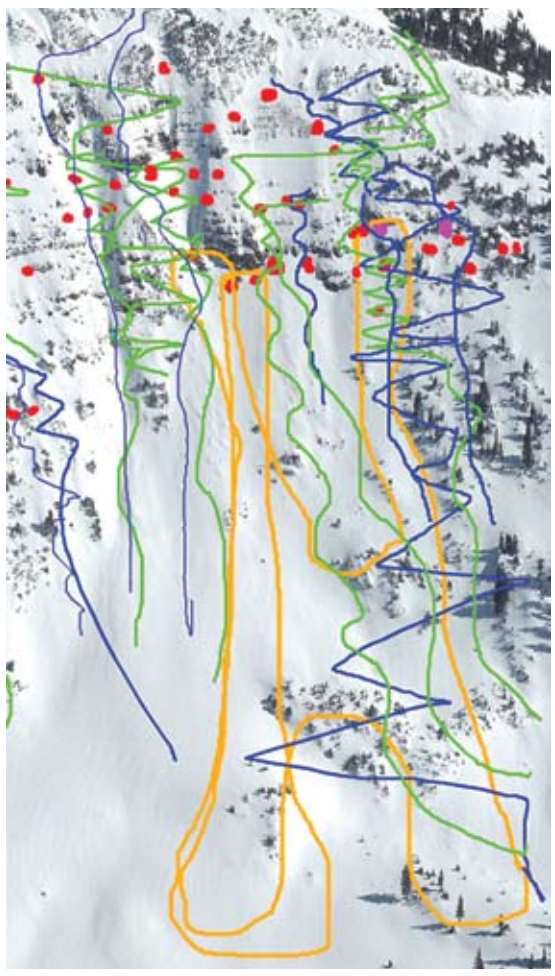
Dimensions: 100cm deep, 650' wide, 1000' down
Snow: HN24: 9" w/.6" water, HST: 33", HS: 65"
Stability: Poor / *Danger:* High
Trigger: 3lb air blast on steep roll between Party Hats and Far Out. Slide propagated right into low skier's right of Party Hats and back up into Ski Heroes. There were significant deep cracks connecting the different sections of this avalanche.

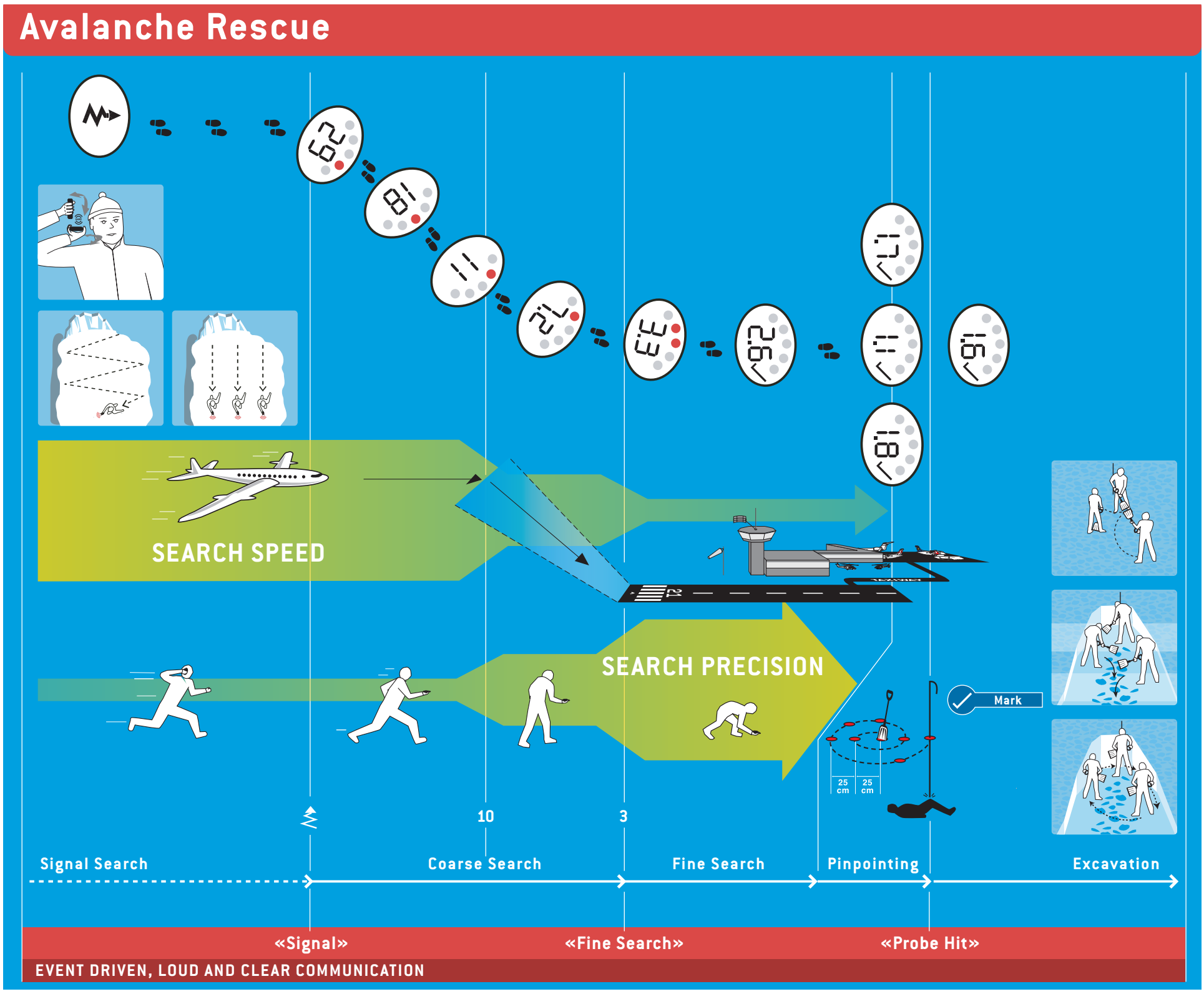




Day of Slide

Cumulative Work in December





Tips & Tricks for the Last Few Meters of Transceiver Search

An overview of the latest search and rescue strategies

Story by Manuel Genswein

Fine Search for Beginners and Average Users

When practicing transceiver search for objects which are mostly much smaller than a human body, one might get the impression that, without bracketing during fine search, no adequate precision can be achieved. For search targets the size of a human body and burial depths of less than 1.5 m this assumption does not hold true.

It should be taken into consideration, however, that with the airport approach and no bracketing, only a lateral deviation and no length deviation can occur.

Especially less experienced companion searchers will waste too much time on fine search in relation to the gain in search precision. For this user group, the airport approach without bracketing will be the best method to reduce the time used to reach the buried subject. In keeping with the airport approach analogy, the airplane will stop on the runway – taxiing to the gate (= bracketing) purposely remains restricted to higher skilled user groups.

Fine Search for Experienced Companion Rescuers, Group Leaders, Mountain Guides, and Organized Rescue

Due to the much increased duration and reoccurrence of training, these user groups reach a level of efficiency and systematic application in fine search which makes bracketing useful. The additional time used for fine search will be justified by higher search precision. Especially since this user group is (justly) expected to handle situations with deep burials.

Spiral Probing

Regardless of the user group, the rescuer finds the point on the surface with the lowest distance indication and/or the loudest signal. Use the shovel to mark this spot as a visual reference for the probing spiral. The transceiver remains in search mode. With the ensuing pinpointing with the avalanche probe, the goal is to find the buried subject with a probe strike. The remaining distance indication in the fine search is the maximum distance to the buried subject. The buried subject might be much closer than the indicated distance, but never ever farther away.

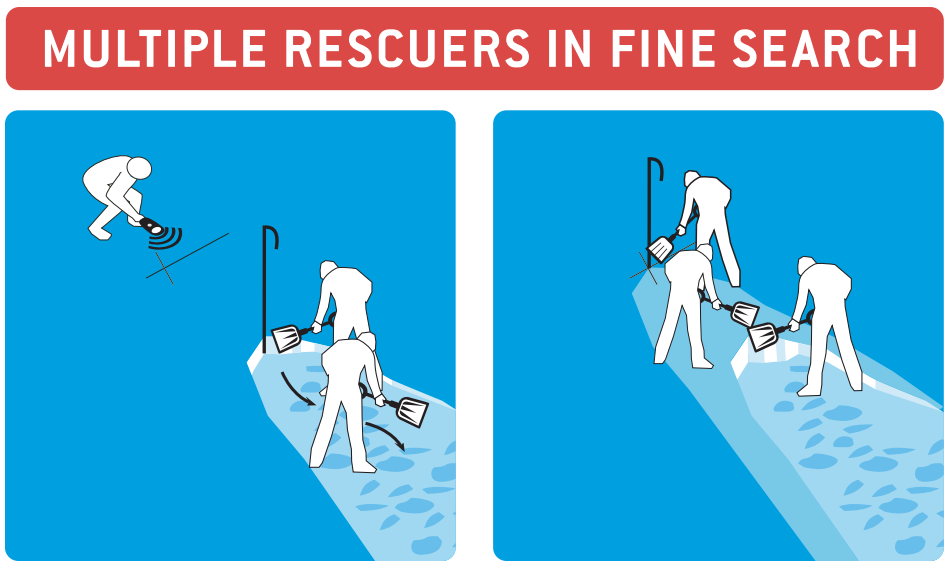
If, for example, the indicated distance is 1.2 m, then it is sufficient to probe no deeper than 2 m. When probing on the spiral, it is hence clear that if one reaches approx 1.5 m radius, one must have missed the buried subject within the already probed area. During probing, the rescuer walks along the spiral. Advanced and professional users probe perpendicular to the snow surface, a detail that can be left out for beginners at the level of "fine search without bracketing."

A probe strike concludes the search: the probe pole is left in the snow and the successful find has to be confirmed to the transceiver by pressing the "mark" function. Do not hold the transceiver close to the snow surface to mark.

Multiple Rescuers During Fine Search

When there are multiple rescuers present in close proximity to the buried subject, it is often seen that they are simultaneously trying to search with beacon and probe. This leads to inefficiency and loss of concentration.

In this case it is advised that one rescuer plants the probe approx one meter below the suspected burial site. This rescuer can then concentrate on the fine search and pinpointing and finish the search thanks to the necessarily vacated space while the other rescuers start the V-shaped snow conveyor belt excavation,



hence already transporting snow from the burial site which would have to be moved later on anyway.

Deep Burials or Probe Strikes Not Possible

If the buried subject cannot be found by probing, then the probe is used initially only as a reference point for the diggers in the V-shaped snow conveyor belt. In this situation it is imperative that enough space is provided for the fine search with the transceiver. Once the suspected burial site has been defined, the probe must not be placed at that spot, but 1 m to 1.5 m ***higher in the slope***. After the first 2 to 3 meters of snow have been removed, the shovelers move a bit back towards the open end of the V. Thanks to the probe having been placed upslope of the expected burial location, the V will already show the width necessary to provide the required space for a second fine search and pinpointing in the V. When the buried subject is located by probe strike, the probe is left in, and the now smaller V can be started with this new reference point directly leading to the buried subject.

The deeper the burial, the larger the area on the snow surface on which the distance indication with a three-antenna transceiver will only show small changes in remaining distance. This is a problem of geometry, not a problem of the three-antenna devices: the large radius of the orb will appear on the debris surface above the victim at a very low angle which will give very small deviation in increase or decrease of distance indication on three-antenna devices.

If working with a digital-only triple antenna device, the rescuer needs to mark two points with the same distance indication on each axis. The middle of the ensuing rectangle will indicate the approximate spot above the buried subject.

Pinpointing in a circle will result in much higher fine-search precision with deep burials. That system, however, is not compatible with digital-only, three-antenna transceivers.

In deep burials, rescuers with one- or two-antenna transceivers (analog or digital) will have to use "pinpointing in a circle" in order to exclude the confusing false (misleading) distance minimals or audio maximums.

For rescuers with three-antenna devices with analog functions, "fine search in a circle" is advised but not imperative. This search strategy was designed specifically for deep burials and delivers – independently from the burial depth and position of transmitting device – very precise search results. Hence the ensuing scenario will be very clearly defined before the excavation process begins. Especially in deep burial scenarios this will save considerable cubic meters of excavation volume as well as precious time.

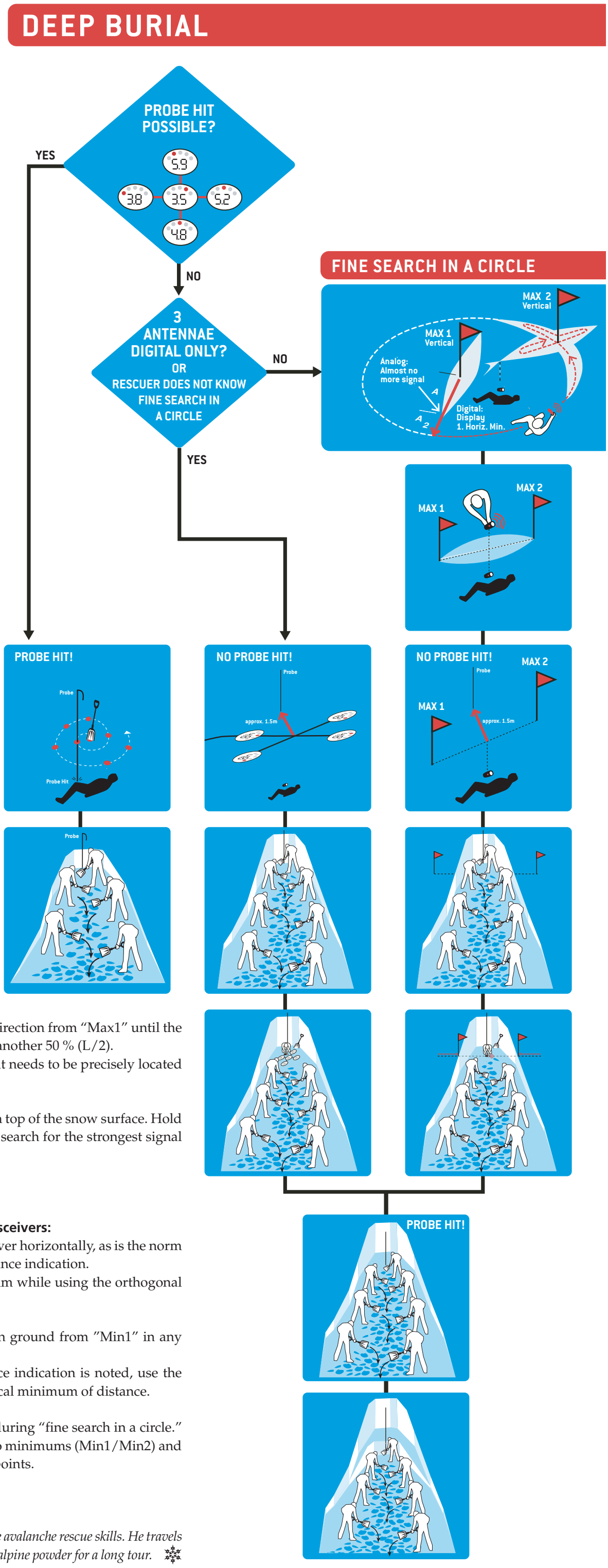
Use of the Analog Function for One-, Two-, and Three-Antenna Transceivers:

- Find the first distance minimum or audible maximum while using the transceiver-specific fine search technique.
- Switch to analog mode, hold device vertically, and define the first audio maximum while using the orthogonal search system.
- Mark this point with visible marker .
- Leave volume on the same level while moving away in any direction from "Max1" until the tone is barely audible (L). Increase distance from "Max1" by another 50 % (L/2).
- Circle "Max1" with that radius. Should a signal be detected, it needs to be precisely located by bracketing.
- Mark this second maximum "Max2" with visible marker.
- The receiver will now for the first time be held horizontally on top of the snow surface. Hold the receiver in axis of the two maximums (Max1/Max2) and search for the strongest signal between those two points.
- You will be precisely on top of the buried subject.
- Plant probe approx 1 m above this spot.

Use of the Digital Function for One- and Two-Antenna Transceivers:

- Search for the first distance minimum by holding the transceiver horizontally, as is the norm with this category of transceivers. Memorize this lowest distance indication.
- Hold receiver vertically and define the first distance minimum while using the orthogonal search system (bracketing).
- Mark this point with visible marker ("Min1").
- Move away the previously memorized distance in meters on ground from "Min1" in any direction.
- Circle "Min1" with this radius. If a clear decrease of distance indication is noted, use the bracketing method to precisely find "Min2", the second vertical minimum of distance.
- Mark this second minimum with visible marker.
- The receiver will now for the first time be held horizontally during "fine search in a circle." Hold the receiver on top of the snow surface in axis of the two minimums (Min1/Min2) and search for the lowest distance indication between those two points.
- You will be precisely on top of the buried subject.
- Plant probe approx 1.5 m above this spot.

Manuel Genswein spends a lot of his time thinking about how to improve avalanche rescue skills. He travels to teach these skills worldwide, but had time at the holidays to get out in alpine powder for a long tour.



Crown from Three Way Peak avalanche at Crystal Mountain Resort (see story on next page). *Photo by Chris Morin*

CRUST THOUGHTS

continued from cover

What Makes a Crust Problematic?

In my opinion it is not about the crust itself, but rather what is around the crust. Is the crust bonded to the adjacent layers, or are there facets around the crust leading to poor bonding? The conditions under which the crust forms, and the subsequent temperature conditions through and around the crust, are critically important.

If a wet layer is subsequently buried by a thin layer of new snow, facets may form quickly around that crust through a process called melt-layer or wet-layer recrystallization *(Birkeland, 1998)*. This buried facet/crust combination can be problematic for weeks or even months.

Crusts that exist at or near the surface during cold, clear weather can have large temperature gradients across them as the snow around them facets due to diurnal recrystallization *(Birkeland, 1998)*. While the other snow is faceting, even more dramatic faceting may occur immediately adjacent to the crust. Subsequently buried, this will again form a persistent and dangerous weakness.

We do not yet fully understand how crusts affect the temperature gradients across them. Cora Shea's groundbreaking work at the University of Calgary shows the complexity of the problem using infrared images of snowpit walls *(Shea et al., 2011; 2012; Shea and Jamieson, 2011)*. Cora's work shows some unexpectedly large temperature gradients around even deeply buried crusts. *(see story on page 28)*

Further, sometimes a crust can be warmer than the snow around it and sometimes it can be cooler for reasons we do not yet fully understand. The bottom line is that there is a lot going on at and around crusts in terms of temperature gradients, and much more work needs to be done before we will have a complete understanding of the gradients and the different processes driving those gradients.

Of course, the reason we are so interested in the temperature patterns and gradients is the subsequent metamorphism of the crusts and adjacent snow. Ethan Greene did extensive laboratory work on snow samples with crusts, and he showed how a temperature gradient across a sample results in more dramatic faceting around a crust than in the nearby snow *(Greene, 2007)*. Interestingly, the most pronounced faceting occurred within a crystal or two of the crust. While these effects dramatically (and adversely) affect bonding to the crust, they cannot be easily detectable with our relatively crude field techniques. Similarly, the gradients being investigated with infrared images cannot be measured with the basic stem thermometers we all use.

What Should Be Done?

So, what should we do about crusts? On the one hand, we know that sometime they do not cause avalanche problems. It seems that this is more likely to be the case when they are buried quickly and deeply and where they are largely unaffected by temperature gradients. On the other hand, sometimes they cause dramatic and persistent weaknesses that lead to difficult-to-forecast avalanches for an entire season.

These latter cases typically occur when the crust and the surrounding snow is subjected to temperature gradients, though sometimes these temperature gradients can occur over short time scales. Crusts tend to amplify the faceting process in the snow nearby, and the resultant poor bonding causes avalanche problems.

Unfortunately, recent research shows that our stem thermometers are insufficient to monitor some of the temperature gradients taking place over short distances adjacent to crusts, and our hand lenses and crystal cards do not always allow us to see some of the dramatic changes taking place extremely close to the crust.

The tools that can help us monitor what is going on around the crust are stability tests. Once a crust is buried, we can use stability tests to help us estimate the bonding to the crust and how that changes over time. Certainly, crusts bear watching and monitoring. There is a lot we don't know about crusts, so be sure to note any unusual observations so you can compare what you see with others.

In the near future we may get more opportunities to track tricky crust scenarios as climate patterns shift and crust-forming events become more common in even our less-maritime environments. So, keep track of those crusts. However, don't assume they will always be a problem. Even with crusts, what I call Ron Perla's First Law of Avalanche Forecasting (the only rule of thumb is that there are no rules of thumb) still applies!

Acknowledgements

Thanks to Cora Shea for quickly reviewing this at short notice!

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Karl Birkeland is the acting director, avalanche scientist, and currently the sole employee of the Forest Service National Avalanche Center. He loves chasing his two daughters around Bridger Bowl and is hoping that by the time this issue of TAR hits our mailboxes, the early season drought of the winter of 2011/12 will only be a memory.

The MLK Event at Crystal Mountain:

A DIY Guide to Tree Removal

Story by Chris Morin

For most of the western US, the La Niña winter of 2010/11 possessed a dual character between its warm start and subsequent record-breaking snowfall finish. The major shift in temperature trend came in early February when snow began falling on the crust formed from a bout of warm weather in late January. At Crystal Mountain in Washington, settled snowfall on Feb 1 was only 68" at 6300'. Over the next two months we received the equivalent of our yearly average of snowfall – some 372" worth. The interface between the warm first half of the season and the abnormally cold and snowy second half of the season was delineated by a crust formed over the Martin Luther King holiday. This MLK crust and the weak snow above it would be the culprit for one of the largest avalanche cycles Crystal Mountain has seen to date.

The MLK crust formed during a two-day period from January 16-17 when 3.5" of rain fell at high freezing levels. Over the next 20 days, dry weather with periods of high freezing levels strengthened this layer into a melt-freeze crust, no longer simply a rain crust. This was followed by 6" of snow on the night of February 7. Avalanche control that morning produced few results within the new snow, and the bond to the MLK crust was generally good. The next four days saw freezing levels mostly below the base area, but a slight warming trend on the 10th and 11th put down a weak crust on top of the Feb 8 snow. The end result of these weather events was a few inches of low-density snow sandwiched between two melt-freeze layers, a structure that has been repeatedly been seen at avalanche accidents in the PNW.

Buried bomb magazine. *Photo by Andrew Longstreth*

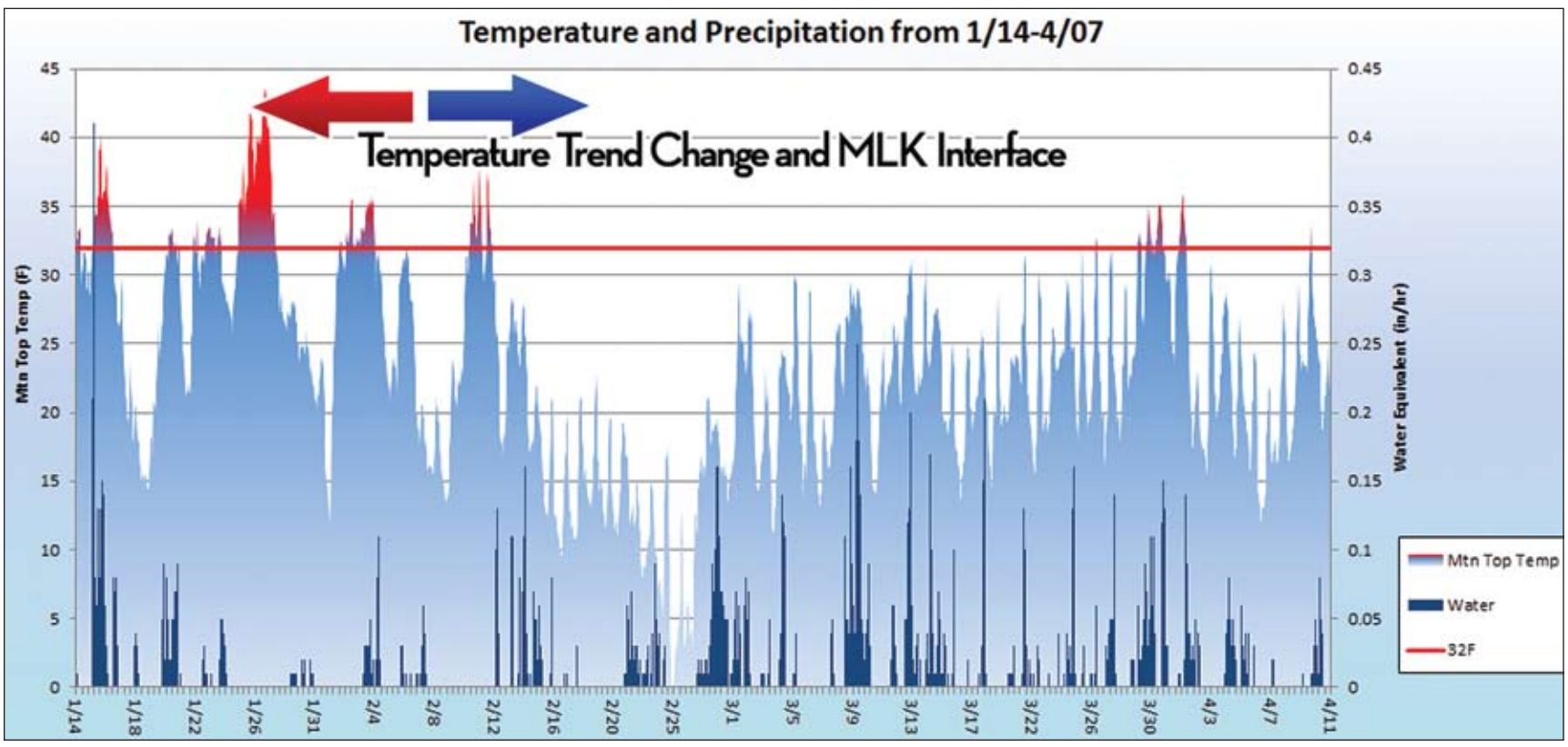
After the brief warm-up, temperatures began to cool with incoming precipitation. The cooling trend created a relatively good bond to the weak trap crust on top of the Feb 8 snowfall. However, strong winds from the south did create some wind slabs on northerly aspects. These would soon prove to be reactive on the facets beginning to form underneath the thin trap crust from the 10th and 11th.

A break in the weather allowed decent visibility for touring on Feb 17. At approximately 2pm that day a snowboarder jumped off a cornice into Little Richards (a large avalanche path dropping 3500') and initiated a 1.5-2' deep release (SS-AR-R2-D2-O on a NW aspect at 6600'). The boarder was able to self-arrest on the bed surface. The path had been cross-loaded from the strong south winds over the past several days and failed on the facets that had formed from the Feb 8 snowfall.

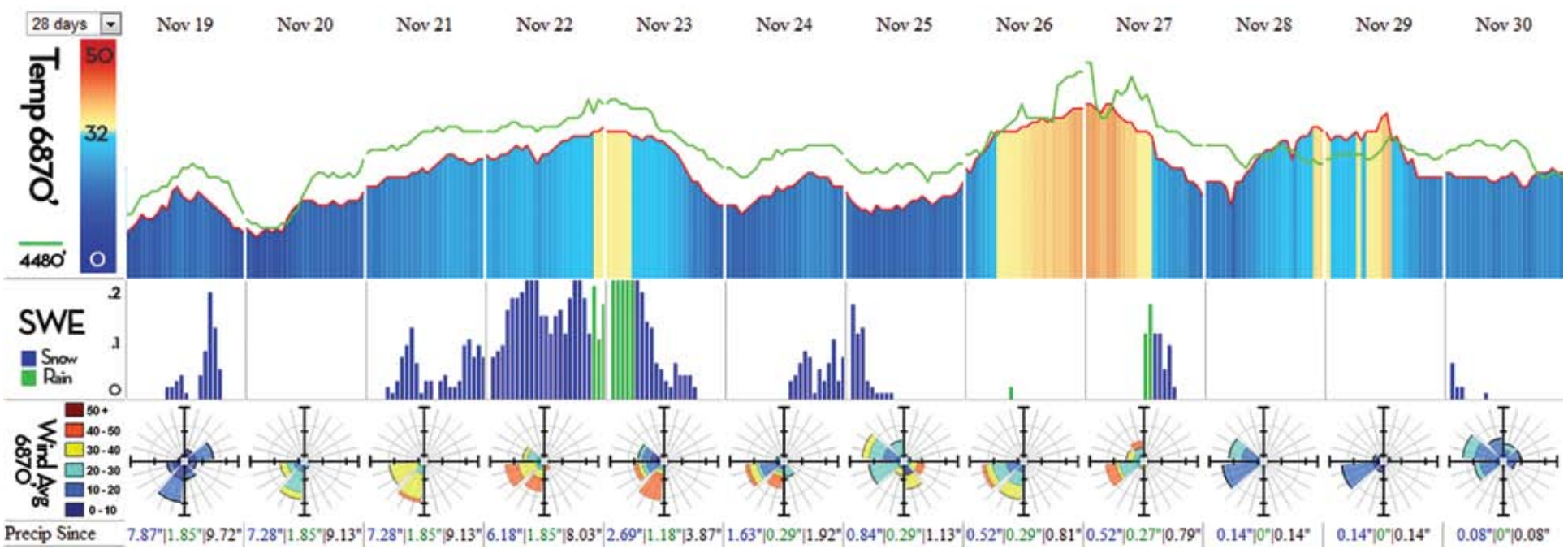
Over 100" of snow would fall until we would again see activity on the MLK crust. On March 11 , after 22 days and another 9" of SWE, a 1.6lb explosive on a N exposure at 6600' propagated a fracture 130' across and 3-4.5' deep on the MLK crust (SS-AE-R4-D2.5-O). Three days later another explosive-induced failure released a 3' deep, 50' wide slab on a NE aspect at 5800' (SS-AB-R3-D2-O). Almost simultaneous to this release, a natural avalanche with a 6' deep crown ran just outside of Crystal's boundary (SS-N-R3-D3-O on a NW aspect at 6000'). Two days later a SS-AB-R3-D2-O on a NE aspect at 5800' released with explosives, and yet another large natural avalanche came out in the Big Bertha path near Crystal Mountain.

This series of results could have heralded the start of a more widespread cycle, especially with the forecast of continued precipitation. However, over the next two weeks, the MLK layer again went dormant with no activity to alert the casual observer to the weakness now lurking deeply in the snowpack.

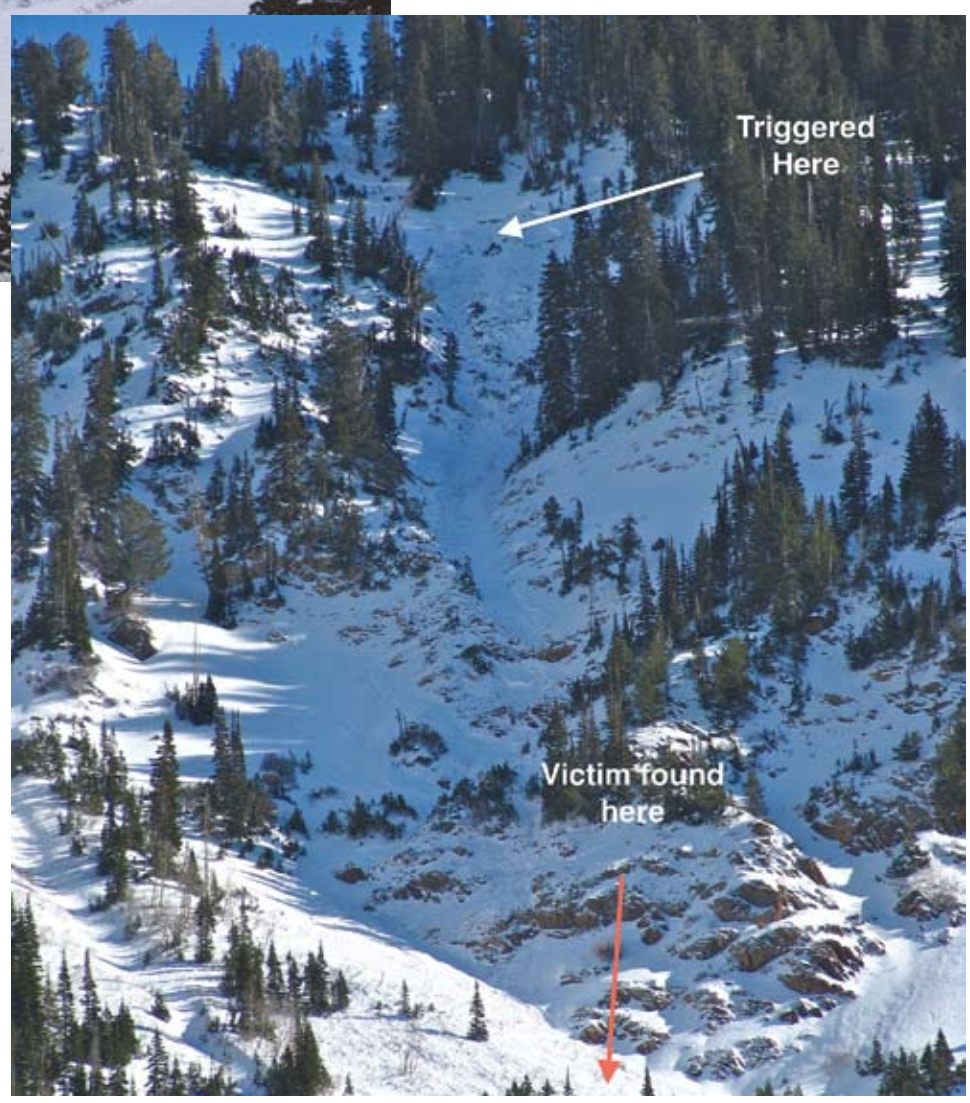
Continued on page 24 ➡



left: Graphic views of data allow the reader to understand a complex story. This graph shows how the MLK crust acquired its load over time, yet never warmed up.



below: The author and Crystal Mountain use this colorful format to visualize the combined effects of temperature, SWE, and wind over time.



Two views of the South Chute at Snowbird, where Jamie Pierre triggered this slide on his third turn and was subsequently tumbled through the rocks. *Photos courtesy UAC*

MADNESS IN THE MOUNTAINS

continued from page 15

We hitched a snowmobile tow to the base of Greeley Bowl to conduct an investigation. It was shocking – nearly everything steep enough to slide had come down. All the slides were 12-20" deep, perhaps 100-200' wide. We skinned up, fearful of hang-fire above. Kobernik's phone rang…and the message prompted his last Twitter message of the day:

> `One more avalanche incident at Snowbird. This one does not sound good.`

Jamie Pierre had long been a celebrated extreme skier in the Wasatch, Montana, and the Tetons. In 2006 he broke the record for the highest cliff jump with a 255' huck off a cliff at Grand Targhee Resort in Wyoming. He, his wife, and two children had only recently moved to the Big Sky area to be a ski ambassador for the Moonlight Basin resort near Big Sky.

On this day, however, he was skiing in his old backyard – Little Cottonwood. He and his partner left Alta, traversed beneath the northwest chutes on Baldy, and entered the mid-Cirque of Peruvian Gulch at Snowbird. Booting, they soon gained the Peruvian/Gad Valley ridgeline, but not before remotely triggering a 2' deep and 600' wide avalanche in the mid-cirque. It's unknown whether the two realized the slide's giant debris pile had engulfed part of their bootpack (poor visibility may have played a role). They strapped on skis and board and descended north along the ridge and then hesitated. The pair were above the South Chute – a steep, treed, rocky, northwest-facing 1000' long run that dropped into lower Gad Valley. With his partner watching, Jamie traversed in, made three turns – and that was it.

By our count at the Utah Avalanche Center, 18 unintentionally human-triggered avalanches that day led to at least six catch and releases, one fractured femur, a yard-sale worth of lost gear, and a fatality that prompted international headlines. These incidents are difficult to understand, and I maintain that this was, yet again, the tragic intersection of instability and desire. The problem was that everyone understood the instability – they just couldn't reign in the desire. Many ski parties triggered or walked past recently triggered slides before jumping into an adjacent slope. What contributed to this day of madness?

- It was the first powder day of the winter – and it fell on a Sunday. ***Hunger and competition.***
- Everyone we interviewed was an expert skier/snowboarder with at least a modicum of avalanche education. Each knew the (unopened Alta or Snowbird) terrain intimately. Jamie had skied the South Chute the pre-season before. ***Familiarity.***
- Their collective experience told them that ski areas are safe – no need to assess the stability, no need to follow safe travel protocol, no need to be equipped with rescue gear. ***Complacency.***
- November 13 was only a few short months removed from a 700" season capped by a stable spring season that lasted well into July.

To be sure, this broad-brushes the crowd. Not every skier or ski party could be defined by these terms – but most of them could. Jamie and his ski partner weren't the only ones to make the wrong call that day. Perhaps their luck had run out. Without question, to know the snowpack takes knowledge. To know oneself takes wisdom. We have a long way to go. This is how our winter began in the Wasatch. As I write this – the day after Christmas – it's the fourth driest season since 1945. It might be a long winter.

Drew Hardesty is a forecaster for the Utah Avalanche Center.

Their collective experience told them that ski areas are safe – no need to assess the stability, no need to follow safe travel protocol, no need to be equipped with rescue gear.

Drew, First of all I will say that Sunday the 13th was one of the strangest avalanche events that I have ever been involved in. Within five hours I had responded to a large slide with injuries, witnessed a second which quite frankly should have killed someone but didn't, and finally lost a friend to a third. Upon first contact with both of the first two parties the first thing said to me was, "Hi Grom." I mean what the hell is going on around here.

I will agree that the powder panic, the terrain familiarity, and the group mentality/race for the goods all played a part. But I also think that when people reach a certain point in their ski careers they begin to think that this kind of slide is a manageable deal. The case in point being me that day. As we went out in response to the first event I went high so that I might be able to ski cut a bit and "cover" the approach for the rest of the crew. It wasn't until I triggered the first piece that I realized just how unmanageable this stuff was. I should have known that before! (Gabe warned me.)

We have to find a way to drill into experienced people like this that there is something different about every day. That every slide is different – and just because you have ski-cut snow like this before, in terrain like this before, on days like this before – today isn't just like before. I don't know how to do that, but I am really sure that it is not another acronym. We have to find a way to diminish confidence.

Finally I want to say that although the accident scene in Gunsight was dusted by another group, that happened before we arrived on scene. We were never directly put in danger by another group. Although I will say the guard was up due to the sheer number of people blundering around in the cloud that day. I mean Jesus! Here we are at the toe working on an injury, and there are other groups just marching by like nothing is going on. They were oblivious!

I've analyzed this day a lot since then, and I still don't know what to say to people to prevent it in the future. I do agree about the "madness" part though.

Go Gently, Dave Richards "Grom"

For the past 11 years Dave has worked as a full-time Alta ski patroller and a part-time helicopter ski guide for Wasatch Powderbird Guides. He is also an avalanche rescue dog handler and member of WBR. Prior to his career at Alta, Dave traveled around the world competing extensively as a professional big mountain free-skier. He has been featured in countless films and magazine covers and brings a vast amount of knowledge and an edgy approach to the KBYG program.

history

Early USFS National Avalanche Schools

Story by Ron Perla

From the early 1950s to 1971, the US Forest Service held an annual avalanche school at Alta, UT. This school was hosted by the Alta Avalanche Study Center (AASC), which reported to the Wasatch National Forest, Supervisor's Office, in Salt Lake City. Students were mostly from the USFS and ski patrols, but others applied and were accepted. Class size was limited to about 30 students on a need-to-attend basis. Some applicants were on a waiting list for a year or two. While it existed, the Alta school was considered a national avalanche school, although USFS training was provided at other locations such as Berthoud Pass, CO.

The Alta school ran for about five days, which included free time for skiing. Students were expected to overnight at one of the Alta lodges since the road was often closed for early morning avalanche control. Road closures could last for several days. During avalanche cycles students had the opportunity to observe firing of recoilless and Howitzer artillery. Sometimes they observed a display of the large avalanches which gave Alta its deserved reputation.

An Alta school in the early 1950s. Front row (l-r): Monty Atwater, Dick Stillman, Whitney Borland, Morlan (Morley) Nelson. John Herbert (white patterned sweater) is seated in the next row, second from right. Ed LaChapelle (v-neck sweater) is fourth from the right. Skiing Hall of Fame-er and USFS Winter Sports Specialist, Slim Davis (white sweater with dark band) is standing in the back row. Morley Nelson in the front row was a Silver Star, Purple Heart hero of the 10th Mountain Division, and world famous for his role in the conservation of large birds.

Case Histories

Indoor classes were usually held after breakfast. Atwater and LaChapelle prepared numerous transparencies designed to make the indoor program as interesting as possible – not an easy proposition if the students had seen the reality of a big avalanche descend Mt Superior during early morning control.

Atwater and LaChapelle's favorite presentations were sequences of transparencies called "Case Histories," based largely on actual events involving snow, weather, avalanches, and human interactions. The first transparency in a sequence would typically begin with "You are the Alta snow ranger," followed by some facts in a developing scenario. At the end of each transparency, the students were asked to give their "Decisions and Actions." Some case histories were drawn from outside Alta, including Switzerland. "Case History One" was limited to a human interaction, an icebreaker for the all-male student body of the early schools, but later deleted when the school became coed.

Outdoor instruction included hazard recognition, route finding, hand-charge routes, test skiing, snowpit evaluation, instrumentation, avalanche sign management, and rescue. Instruction, indoor and outdoor, was provided by AASC staff, Alta snow rangers, visiting snow rangers, experienced ski patrol, and other visiting dignitaries.

Exciting Lessons

Students were expected to ski along with the program which could get exciting – too exciting at times. For example, one afternoon LaChapelle told me to prepare a demonstration snowpit in Albion Basin. LaChapelle led the students to the snowpit. I began handing up grain samples to be passed around to students and instructors. I handed up a sample of large depth hoar grains which impressed LaChapelle. It was agreed by all that this was a very unstable snow profile. Then as if on cue, as if staged for the school, two skiers released a slab avalanche high above us, in full view of our astonished snowpit class. The avalanche carrying the two tumbling skiers seemed to be heading directly toward us. I jumped out of the pit like a cougar, momentarily not sure which way to run, but it was a moot point when the avalanche stopped not much more than 50 meters from our snowpit. We all ran toward the avalanche debris. The two skiers were partially buried, tangled in a grove of small trees. One had a broken leg, diagnosed and comforted quickly by several patrollers from our class. The fast radio call for a toboggan must have been music to the victim's ears.

One afternoon was always devoted to simulated rescue of a buried dummy. The students assembled at the USFS garage and awaited the arrival of the witness. Naturally, we would try to make the exercise as convoluted as possible. At the final Alta school, winter 1970/71, the witness who approached the garage to sound the alarm was Alexis Kelner (illustrator of the USFS *Avalanche Handbook*). Alexis pretended he couldn't speak English and described the incident in Russian with animation and excitement.

Passing the Torch

Sometime during the 1970/71 season, Roy Feuchter wrote a review of avalanche problems within national forests for the USFS Chief's Office, Washington DC. It covered past history and the trend for the USFS to phase out from performing avalanche control for ski areas and highways. One of Feuchter's ideas was to develop a "National Avalanche Training Program" to transfer USFS avalanche expertise and thus help fill the void as the USFS withdrew from its active role in ski areas and highways. To put it bluntly: the USFS won't do it any more, but we'll show you how it's done.

Feuchter proposed the training to be in three phases. Phase I would center around indoor auditorium presentations to a much larger audience than could enroll at an Alta school. It would not require the skiing skills required for the Alta terrain. Managers and others who didn't ski, or no longer skied, could learn something about avalanches – at least the theoretical something.

Phase II would include smaller field sessions held at various locations in the Western mountains. Skiing skills could be useful or required. Phase III would provide follow-up consultations at the participant's home area, presumably if this follow-up was requested.

I participated only in the early implementation of phase I, the indoor lecture phase, called the USFS National Avalanche School (NAS). I had no firsthand experience with phases II and III which the USFS contracted to consultants Juri Krisjansons, Rod Newcomb, and Norm Wilson.

The First NAS in Reno

In early summer 1971, Pete Wingle was tasked with finding a suitable auditorium, preferably in a city with reasonable hotel rates and night life for an after-class outlet. In a stroke of genius, Pete Wingle chose Pioneer Auditorium in Reno, NV – a city with gambling-subsidized hotel rates and bright lights. Shortly after confirming Pioneer Auditorium for three days in November 1971, Roy Feuchter convened a meeting in Reno to design the program. I can't remember all who were at that meeting; it was a large group from within and outside the USFS. Martinelli, LaChapelle, and Perla were there for certain. Probably so were Dale Gallagher, Norm Wilson, Roland Emetaz, Dick Spray, Pete Wingle, and Bill Hotchkiss (avalanche director of the National Ski Patrol System).

The meeting was chaired by Feuchter who basically said, "We're having a school, now design it." After going around in the usual committee circles, we converged on a program, assigning lectures to available "experts."

The first NAS was well attended, fun, and a success, even if quickly organized. The combination of the Pioneer and Reno was a real winner. In one of the highlights, participants sat before an avalanche simulator, borrowed from USFS fire training. Dale Gallagher programmed the simulator with confounding situations, mimicking the Case Histories of the now defunct Alta school. Bill Hotchkiss, quintessential entertainer, kept things moving when given the floor. He had a real knack for auditorium speaking, a skill that many of us early instructors lacked. As I recall, there were a limited number of exhibits set up in the Pioneer lobby. John Lawton exhibited, tested, and serviced our Skadis, which at that time were the only transceivers in the US. Atwater's avalauncher was considered by the USFS as a work in progress and not included as an approved exhibit for the 1971 NAS. And so it was decided to do it again, next year: November 1972 in Reno.

The Baby that Became ISSW

Meanwhile, the AASC was closed, and I was thrown out into the snow. Martinelli gave me shelter at Fort Collins to co-author *The Avalanche Handbook* and help organize the 1972 NAS, which I did by mapping the lecture sessions in sequence to each chapter of *The Avalanche Handbook*, now designed to be the NAS textbook. Three days of lectures would cover the handbook. It occurred to me that a three-day Reno party was just too short. We could extend it two more days (with Thursday and Friday) by adding a symposium called, "Advances in North American Avalanche Technology." We could go into more advanced research subjects and invite presentations from the scientific community. Interested students and instructors could hang around Reno another couple of days. Some could come to Reno only for the two-day symposium. Martinelli and Feuchter approved the add-on.

It turned out that most did stay the full five days. Papers were presented by Montana State University, University of Washington, Colorado State University, Martinelli's project, US Army CRREL, and National Research Council of Canada. For example, St Lawrence and Bradley from Montana State University presented their studies of Ultrasonic Emissions in snow, innovating

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DIY TREE REMOVAL

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By the end of March, Crystal Mountain had accumulated over 16" of water and almost 200" of snow on the MLK interface. Although impressive numbers for the 50-day stretch, they are not uncommon for the wet Pacific Northwest. What was exceedingly rare for such an active stretch of weather was the lack of a single warm spell that would bring the freezing level much above our base area. In the starting zones at Crystal Mountain, no rain or even temperatures above freezing had been present since the rain event that created the crust.

Finally, during the last day of March and the first day of April, Crystal Mountain saw freezing levels reach 7000' with just over an inch of rain at the summit. Although not an extreme weather event by any measure, it would prove to be enough to create some of the most destructive avalanches originating from within ski area boundaries that the Northwest has seen.

On April 1 a natural avalanche occurred in the permanently closed Rockface area at Crystal Mountain. Debris reached open terrain, and a search was conducted with no results. After removing search personnel from the area, the rest of the Rockface area was shot with impressive results, each releasing on the MLK layer. The largest avalanche tore out 50+ trees, many 2' plus in diameter. It was the largest slide seen in that area since modern control work efforts, but ended up being par for the course over the next two days.

The following day a number of control teams were sent out with heavy packs to search for the same instability seen the day before. A number of R3D3 avalanches were initiated in the ENE-facing Niagaras area of Crystal's Northway. Crown depth was 3-5'. In the steep NE terrain of Bear Pits, all shots produced fractures from 4-8' in depth, tearing out 30' trees and depositing them at the bottom of the path.

A heli mission was set up for the next day to put large test shots in key locations. A 25lb bag of ANFO was placed skier's right of the Niagaras results from the previous day. The subsequent avalanche would move over 1,000,000 pounds of snow, tear out over 1000 trees, and almost reach the employee housing area along the access road (AH-SS-R5-D4-O on an ENE exposure at 6200') . A second shot in the hangfire had a similar effect, and after a few more tests in strategic locations, the decision was made to leave the majority of terrain closed until the snowpack had time to adjust to the warm-up.

On April 8, after five days of cooling, a final heli-mission was launched with minimal results; the only exception being an 8-15' deep release on steep north-facing slope. All other tests produced no result. After a few more days of cold weather, the remainder of closed terrain was re-opened at Crystal with no activity.

The MLK event at Crystal was notable for a number of reasons. First, it produced avalanches of sizes not commonly seen at our ski area. It also occurred much later in the season than most of our in-area avalanche cycles. Most interestingly, however, is the weather record leading up to and during the event. This was not a well-forecasted, extreme hazard type scenario. In a location that regularly will see 3"+ of rain in a 24-hour period at 9000' freezing levels, a brief warm-up to 7000' with relatively light precipitation is not the usual recipe for large-scale destructive avalanching. In this case, however, with 50 days of abnormally cold temperatures, a weak substructure, and almost 200" of snow, all of the ingredients came together to create a deceptively unstable snowpack.

It is important to track these weather trends in a graphical format over long periods of time to enable the use of pattern recognition in daily forecasting routines over these long-term cycles. Most avalanche forecasting organizations currently track weather on an hourly time scale. Just looking at wind speed, temperature, and precipitation from one station, 3600 pieces of data would have to be assimilated over the 50-day period of the MLK event. This is far too many to look at as individual data points, and even when broken down by day, 150 numbers would still have to be analyzed congruently. Even a rudimentary plotting solution greatly simplifies this data assimilation.

Flagging 50' up a stand of trees near the bottom of the Niagaras path. All of the clearing seen was created by the slide.
Photo by Chris Morin

Lastly, it is important to realize that those working within the ski area boundaries for many years may have detached themselves from the true possible runouts of many of their paths. While skier compaction and consistent control work usually yield results that run along well-understood distances, during times of deep instability the original and longer runout distances may be achieved. A careful look at the tree cover in your starting zones will many times reveal unexplained differences in tree age. The large avalanche we observed during our heli blasting was not unparalleled in terms of its overall size; other ski areas have experienced similarly sized results. It was however extraordinary in the path it took through a seemingly mature forest. Almost none of the path was without tree cover. Yet, upon closer inspection of previous aerial photographs, effects of a similar event in lost history are in fact present.

The MLK cycle was a difficult-to-forecast event, and we hope to improve not only our program, but the general understanding of deeper stability releases through the study of its evolution. Geographically, it was a very widespread weak layer, and we are eager to hear what other programs learned from the event.

Chris Morin is the assistant snow safety director at Crystal Mountain Resort. He is also the avalanche forecaster for the BSNF railroad in Washington State and runs the avalanche courses for International Mountain Guides. He skied almost 200 days last season, but hopes to get out more this year.

MLK Crust Thoughts from Mike Richardson

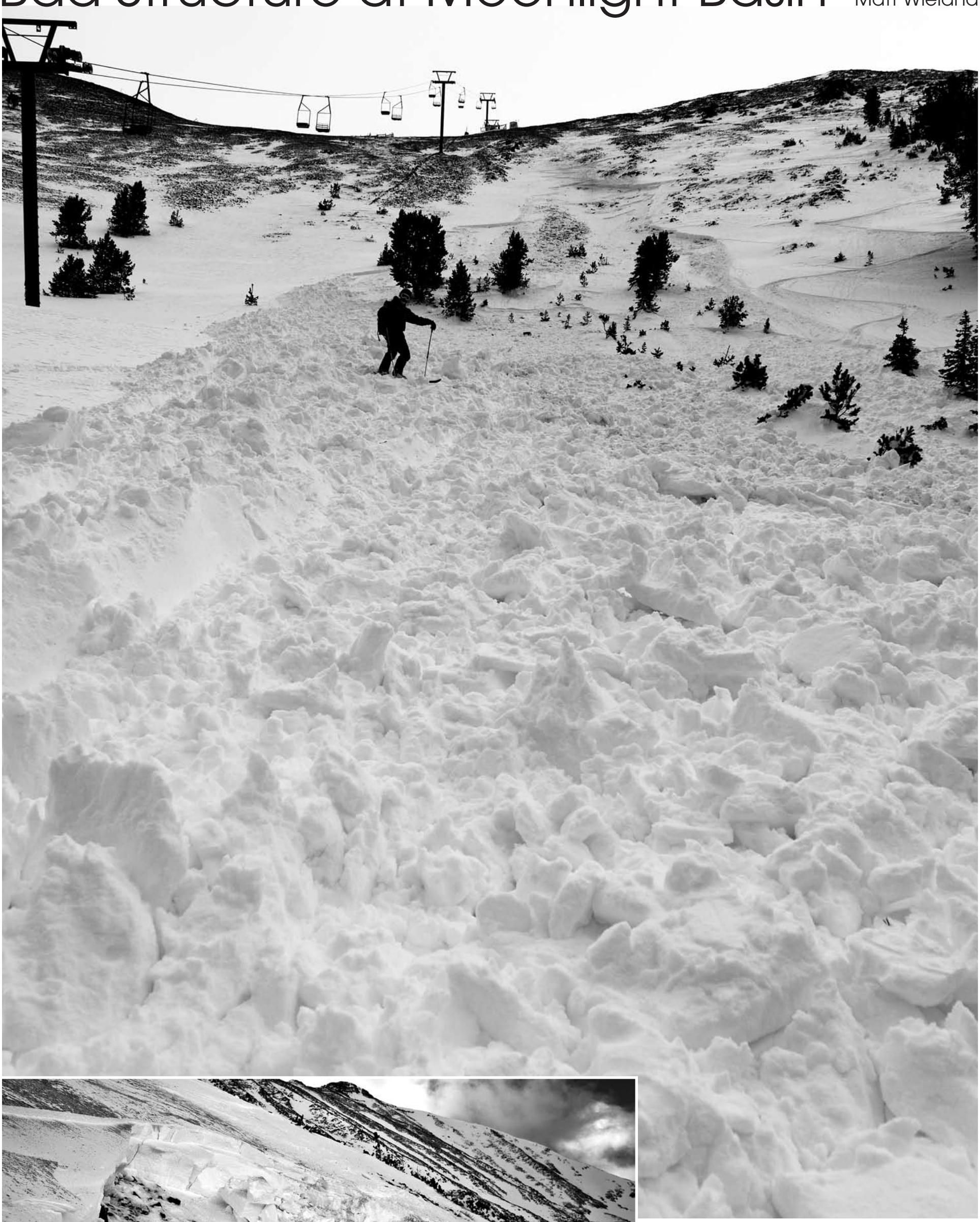
The MLK crust certainly kept me away from lots of places and on my toes in general. The PNW isn't exactly a hotspot for PWL (persistent weak layer) activity, and even when there is a PWL, activity on the layer is not usually as pronounced as one might experience in the Intermountain ranges of North America.

What I remember most was the amazing consistency in shear quality I observed on three or four separate ski days over a month-long period. The layer had a frightening heft to it, and I think its relative mass was a large factor in its persistence. Actually, I was also surprised there weren't more disasters!

Mike Richardson.

Bad Structure at Moonlight Basin

Submitted by
Matt Wieland



These photos were taken December 2, 2011, on our first day of explosive control. We had a small team controlling the first few zones in our Headwaters area. All but one of the chutes failed on depth hoar to the ground.

Above: The slide in Headwaters Bowl failed on depth hoar to the ground on a 1kg charge.

Left: Crown line in Cold Spring: hard slab failed on depth hoar to the ground on second 1kg charge.

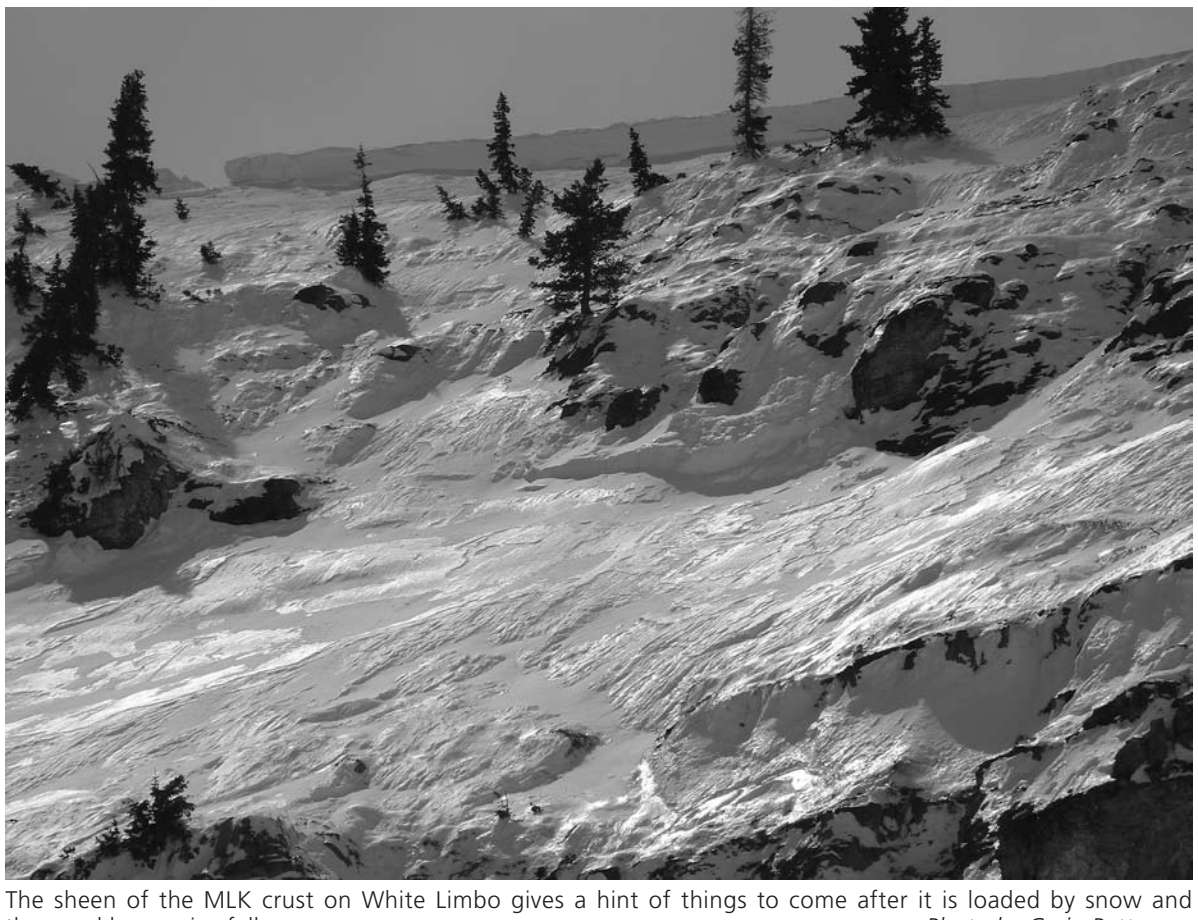
Both photos by Matt Wieland

Matt Wieland is a long-time patroller at Moonlight Basin ski area in Montana.

MLK Rain Crust, Deep Slabs & Cornice Failures in the Southern Wasatch

Story by Bill Nalli

A close-up mug shot of the bad guy. *Photo by Bill Nalli*



The sheen of the MLK crust on White Limbo gives a hint of things to come after it is loaded by snow and thumped by cornice fall. *Photo by Craig Patterson*

During the first few months of 2011, the southern Wasatch experienced a series of deep-slab avalanches that were specifically related to the MLK rain crust and big cornice failures. There's been lots of talk about that now-infamous rain crust but there were a couple additional characteristics of last winter that ended up being important players in this intermittent avalanche cycle: specifically, above-average snow densities for much of the season as well as a few exceptionally large wind events that helped form the roots of large cornice formations.

More weather details are covered in Ian Havlick's article *(see next page)*, but I'll just mention that by January 1 the Provo area mountains received 475cm of snow with 875mm of H2O. That amounts to 300% of normal snowfall and 400% normal water up to that point in the season. Combine that with a windier than normal season (in my opinion), and you end up with a really deep snowpack and some epic overhangs along our more exposed ridges. As time went on, those cornices started to become more sensitive to both new loads and human triggers.

As the crust got buried deeper and deeper we were constantly wondering just how much of a load it could handle. In places where it was up to 10cm thick it seemed likely to stick around the rest of the season. I even heard talk of the idea that the MLK would be the new ground level. There were, however, many places where the crust was much thinner, and in some places it was multi-layered. We then began to see a change in the quality of the crust over time as it slowly started to deteriorate. And as you would imagine of any vapor barrier of this kind, over the course of many weeks large grain facets began to grow both above and below it.

Stability test results were difficult to interpret. CTs and ECTs don't tell the whole story because once you cut all four sides of the column, you are lessening the strength value of such a strong layer. I did a few PSTs where, when cutting all the way up the weak layer below the crust, I was left with a peninsula of slab hanging freely above my snow pit. AK blocks and Rutschblocks seemed to be better tests for this snowpack structure but often ended with no results. With all tests, when I did get results, the strength scores were very high and often pointing to lots of stored energy with Q1 and Q2 sudden planar shears.

After a while I began recording strength scores for ECTs in a way that I had never done before. At the end of 30 taps when you would normally record ECTN, I continued to pound harder and harder on the column. When the column would fail after five or six more pounds, I started scoring it at ECTP 30+. All of this was starting to highlight what I believe was the only way to get this structure to fail. ***Big triggers.***

I don't have any real data to back this claim up, but I feel that the cornices on most of the upper-elevation ridgelines were 20-30% larger than what I normally see. Not all of them were rooted badly, but in many places an extra curl created some ultra-sensitive giant overhangs. I recall numerous close calls with skier-triggered cornice failures reported, and then, starting in late February, we saw the beginning of an intermittent avalanche cycle. The pattern: moderate-sized snow storms overloading truck-sized cornices leading to D3-D4-wide propagating avalanches.

From February 20 to April 11, I recorded 13 HS-NC-R3,D3-4-O, 1-2m in depth, on Mount Timpanogos and Cascade Mountain. Almost all of these were on aspects from east to northeast above 10,000', failing below or between one of the MLK crust layers at 2-3mm facets. All of them had large missing chunks of cornice on the ridges above them. The one exception was on a north-facing slope at 8400' that was triggered by a group of skiers as they approached the cornice. This particular slide propagated about 1000' wide.

The later into the season, the deeper these slides got and the wider they would propagate. We are left to wonder what would have happened if things warmed up fast and introduced liquid water to this layer. Mother Nature was kind to us and extended the season well past normal, just gradually warming up and easing out of winter. I didn't see any large slides after April 11 and none related to wet layers, even given our 300% plus of normal snowpack left on the ground well into summer.

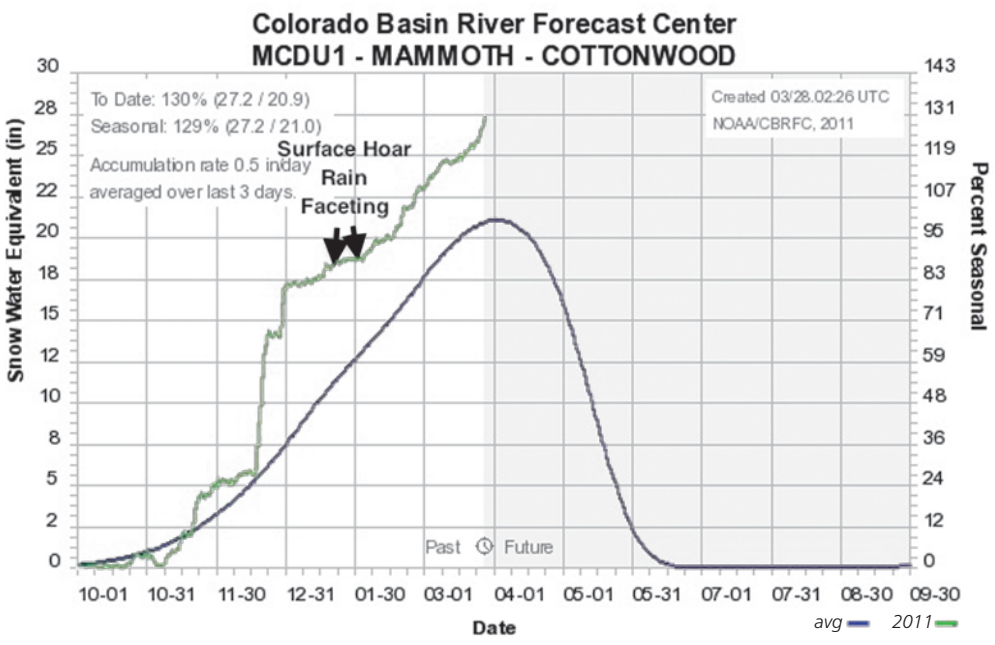
Based on structure alone, I was never fully able to trust the big steep slopes in the southern Wasatch. At any one time, we never had a widespread cycle related to this unusual crust, but taken as a whole, that's exactly what it was: an intermittent, widespread, pockety avalanche cycle. It seemed highly unlikely that the weight of a skier would be enough to activate one of these things, but still I found myself at the top of each run wondering if I was right. I wasn't willing to trust that assumption operationally either as we continued to use artillery in the big paths later in the season than ever before.

As this current "non-storm" continues to rain/rime into the upper elevations I realize that I'm a firm believer in the power of positive thought. The timing and irony of this email has reminded me of the power in the energy of our thoughts. We must be diligent in focusing our minds on that which we wish to see come to be. While I find some of this crust stuff fascinating, I will now switch my thoughts to the effects of nice, light-density snow storms over a long period of time.

Bill Nalli runs UDOT's avalanche program in the southern Wasatch and lately has been moonlighting as an instructor with AAI. With the slow start to winter this year he has had time to reflect on many things, especially: Behind every good man is a great woman.

Slopes with widespread weak layers buried deep need big triggers such as truck-sized cornices. *Left:* Timpanogos Ridgeline 2/28/11 *Right:* White Limbo 4/11/11 *Photos by Bill Nalli*

This HS-N in Mineral Fork broke on faceted snow just below the MLK crust.
Photo by Spencer Wheatley



You would have wanted an umbrella in the Wasatch on MLK weekend, 2011.

Alpenglow highlights a crown in Cascade Cirque 3/1/11. *Photo by Bill Nalli*

Wasatch Rain Crust Event: MLK 2011

Story by Ian Havlick

Ahhh…the Wasatch. The Greatest Snow on Earth. Avalanches. Rain? Last season was one to be remembered. For most, it will be the season remembered for snowfall totaling nearly 800" in the Tri-Canyons area, generally good stability, ski descents etched well into August, and below-average numbers of human-triggered avalanches and fatalities.

However, in early January, the season was beginning to look much more ominous when a widespread layer of surface hoar was buried January 8. Large feathers up to 10mm were neatly tucked in on their melt-freeze crust bed by a 4", 4% density duvet. Then another layer of surface hoar was buried on the 11th. Many thought those layers would quickly become the monsters under the bed. By blessing or curse, a warm, moist, Pacific-tapped storm rolled in mid-day of January 16 as light drizzle in the central Wasatch, and by early evening the drizzle had intensified to full-on rain nearly to the ridgetops (9500'). The deluge lasted through the night and created the now-fabled Martin Luther King Jr (MLK) rain crust. Above 9500', more of a slush/rime crust was deposited.

Wendy Wagner was out touring with her family that day near the Alta perimeter and said, "It was so miserably wet and windy, we got to the top of West Bowl just to slog (seriously, slog – no skiing involved, the new snow was so saturated it just stuck to our skis) back down Emma4 to the car and straight to the Porcupine Grill for lots of beers."

The storm ended up dropping 1-4" of snow water equivalent (SWE) mostly in the form of rain, creating a rain/ice lens varying in thickness from thin to impenetrable across the northwest and northern Intermountain region. There was quite a bit of spatial variability to this rain crust with its statewide distribution across Utah, but once in the mountains that got the rain, the distribution seemed more uniform and widespread in almost all elevations and aspects, with the exception of a thicker crust on more open, southwest-facing (windward) slopes and ridges.

Down south, in Moab's La Sals, Dave Medara wrote in the January 18 advisory, "The mess that is now the northern Utah snowpack and the storm totals of the Rockies to our east have all been missed here. No rain, no snow. About all we've had that is storm related is an increase in winds over the last two days."

Continued on page 29 ➡

Hot Crust, Cold Crust

Story by Cora Shea,
Bruce Jamieson, and
Karl Birkeland

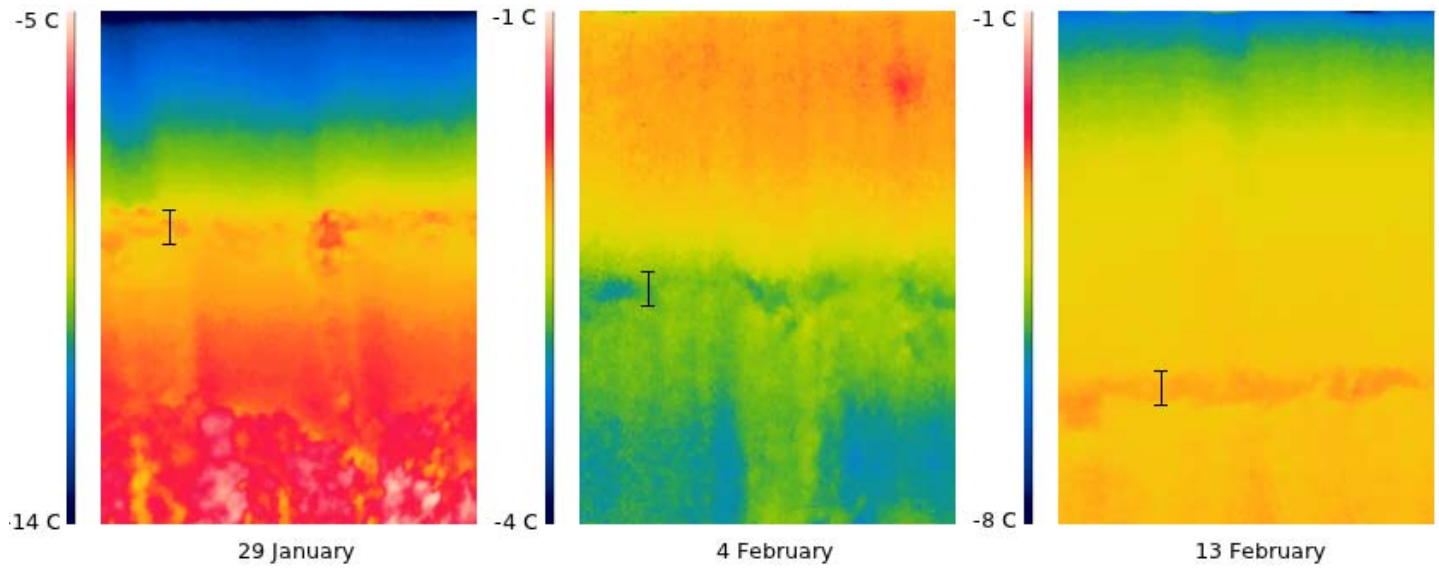


Figure 1: The relative temperature of the crust changed from day to day over the season. The crust is marked by the black line in each image; it is about 1cm thick. Each image has the snow surface at the very top. On January 29, the crust was warmer than the snow above and below. On February 4 it was cooler than the snow above and below. And, on February 13, the gradients reversed again when the crust became relatively warm. The absolute temperature of the crust followed that of the snowpack – on cold days the crust was colder than on warm days, just like the rest of the snow.

For this crust issue of *The Avalanche Review*, we thought you might be interested in our study from the Canadian Rocky Mountains.

This past winter, we tracked a crust in a very shallow snowpack of less than 70cm. We looked at the temperatures in and around the crust by using a thermal imager. With a thermal imager, we could measure the amount of heat coming from a pit wall on a very fine scale. This allowed us to measure temperature gradients across snow layers as small as a few millimeters.

In the case of the crust, we expected it to be buried with a certain amount of heat. We also expected that this heat would then dissipate over time and grow facets.

However, that is not what happened. Instead, we saw the relative temperature of the crust – warmer or cooler than the adjacent snow – go back and forth over the season. You can see an example of this in Figure 1. And, when we looked at the temperatures around the crust every hour over a single day, we saw the relative crust temperature reverse within hours.

So, our data show that crusts undergo much more complex temperature changes than we originally thought. We believe this hot crust, cold crust effect may have been from temperature gradients across the entire snowpack. At some times, the crust may have had good conduction through the ice matrix alone. But at other times, the gradient from ground to surface may have exceeded the ability of the ice to conduct, and so forced more heat transport via vapor through the pores. This would bring heat – latent heat – to the crust as the vapor crossed the pores and deposited.

The depositing vapor would then also do other things, like form facets. This may explain why facets tend to grow at the top and bottom of a crust – these

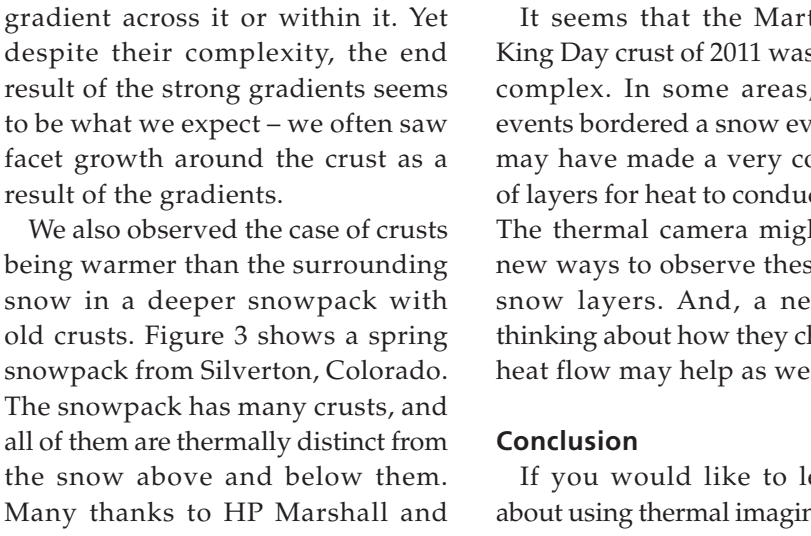


Figure 2: The black line shows where the crust is located on this small area on a snowpit wall. The crust is about 1cm thick. On average, the crust is warmer than the snow immediately above and below, but this is certainly not obvious. And, the complex structure of the temperature gradients might play a larger role than just relative warmth or coldness.

areas may be gaps in ice conduction, and thus more dependent on water vapor motion for transport of heat.

This appears to be a very complex process at the crystal scale. Figure 2 shows a close-up thermal image of a crust in a snowpit wall. The crust does not have a simple temperature gradient across it or within it. Yet despite their complexity, the end result of the strong gradients seems to be what we expect – we often saw facet growth around the crust as a result of the gradients.

We also observed the case of crusts being warmer than the surrounding snow in a deeper snowpack with old crusts. Figure 3 shows a spring snowpack from Silverton, Colorado. The snowpack has many crusts, and all of them are thermally distinct from the snow above and below them. Many thanks to HP Marshall and Andy Gleason for organizing a great Geek Week to visit this snowpack.

Still, we do not have many direct answers. We do not know whether this type of pore-space heat transport always grows a specific type of crystal – like facets – or not. If it grows facets only sometimes, we do not yet know how to recognize the temperature gradients for other types of growth. However, we hope to learn this during the current season.

It seems that the Martin Luther King Day crust of 2011 was especially complex. In some areas, two rain events bordered a snow event, which may have made a very complex set of layers for heat to conduct through. The thermal camera might provide new ways to observe these complex snow layers. And, a new way of thinking about how they change with heat flow may help as well.

Conclusion

If you would like to learn more about using thermal imaging for snow studies, feel free to contact us or visit www.ucalgary.ca/asarc. We too are learning as we go, but we welcome ideas and discussion.

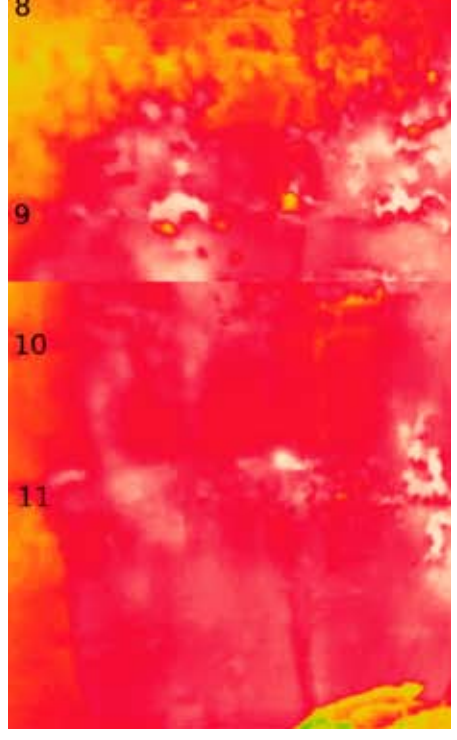


Figure 3: The snowpack above is about 1.5m in depth. Number 1 (upper left) is the snow surface. Numbers 2 through 11 are all individual crusts. Even these old, mature crusts are thermally distinct in March. These temperature gradients appeared on a cooler day with 8/8 clouds and snow.

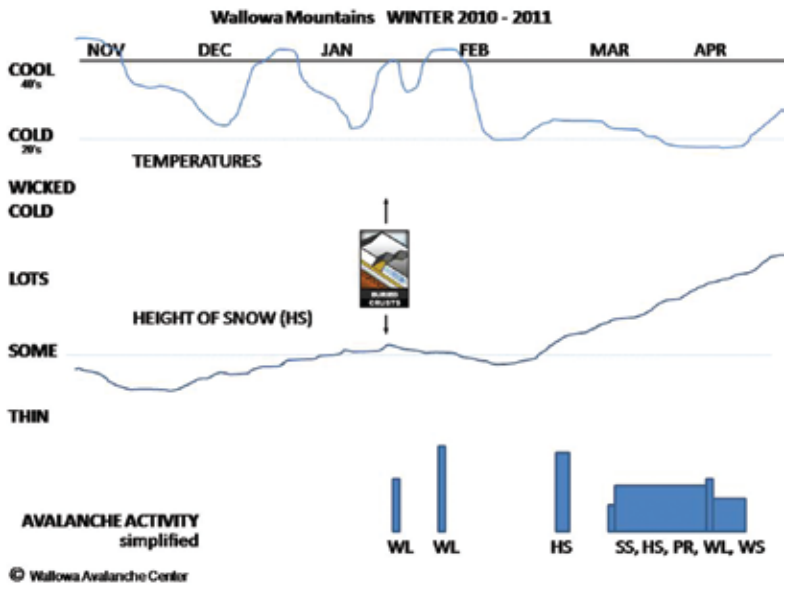
Cora Shea finished her doctoral studies in geophysics at the University of Calgary this past October. Bruce Jamieson, Karl Birkeland, and Cora have joined in for another thermal investigation season in the Rockies, hoping for interesting layers to study and yet lots of safe skiing.

Ice Crust Reminiscing
from Ron Perla

LaChapelle told me the most unstable condition he ever saw at Alta was the 1963 cycle that ran on a buried ice crust. One artillery hit and fracture lines propagated from gulch to gulch, canyon to canyon, Ray Lindquist said.

But I didn't see it since I was in SLC waiting for the road to open.

Ron Perla, December 9, 2011



Wallowas: A picture is worth a thousand words

Story and photo by Keith Stebbings

Take a look at these two pics. They are self explanatory. This graph I put together for a portion of a NSP Instructors Conference. I was helping as a guest presenter for Chago. Chago wanted some indication of what the Wallowas did last year snowpack-wise. This graph, although representative, would not be something to use for research purposes obviously. It does highlight the deposition of the crust event and the delayed reaction of the activity once the snow pumps turned on.

Keith Stebbings, Wallowa Avalanche Center

WASATCH CRUST

continued from page 27

160 miles to the northwest, along the Manti Skyline, UAC forecaster Grant Helgeson told a different tale in his January 21 advisory. “Stout rain crust on top, buried surface hoar 5-10" below. Yes, the rain crust is quite strong and supportable, and for the most part, it’s keeping the surface hoar from ever feeling our weight. But surface hoar only needs a hair trigger to activate, and I'm not 100% certain that the rain crust will keep us out of the surface hoar everywhere.”

The northern and central Wasatch experienced conditions very similar to the Uinta mountains in the days after the MLK rain event, which is summed up neatly with this advisory nugget: “There is now a nice glaze in the form of a rain crust throughout the range all the way to ridgetop. Remarkably, the surface hoar remained intact at mid & upper elevations. Riding conditions are pretty poor. You’re either riding right on the rain crust, or on a few inches of rime snow on top of the rain crust.”

The effects of the MLK layer would be seen for much of the winter. GR Fletcher of Snowbasin shared his operational experiences at the 2011 Utah Snow Avalanche Workshop (USAW) about delaying the opening of certain terrain at Snowbasin for over 40 days, not due to avalanche hazard, but to “slide for life” concerns patrollers voiced while accessing terrain. The “slide for life” dangers would be echoed by dozens of observers for over a month throughout the range, due to a lull in accumulating snow and an excess of wind that kept the rain crust near the surface.

Starting in early February, snow fell under calmer conditions, covering the MLK crust on all aspects and elevations. The crust went (mostly) silent until March when the aging MLK crust would be seen again in the form of huge, deep slabs releasing throughout the Utah ranges, from the Manti Skyline in the south to the Ogden-area mountains 150 miles north. A majority of the deep-slab avalanches were triggered by huge natural cornice failures due to wind loading and/or warming. However, on one occasion in the Manti Skyline, the weight of two skiers standing on a ridgeline was enough to fracture a VW-sized chunk of cornice, which triggered a massive 4-8' deep hard slab 350' wide, taking three members of the party 900 vertical feet down slope, resulting in Utah’s second avalanche fatality of the season, despite a textbook rescue. As with this fatal slide, the majority of these large avalanches ran on the large surface hoar preserved below the MLK crust, as well as near-surface facets above the crust.

These slides regularly ranged in depth between 4-12' + down. A number of these slides shared the presence of rock bands either on the bed surface or at the stauchwall, creating a kind of “hanging snowfield” that left the slab unsupported and disconnected from the surrounding snowpack. These rocks likely also interrupted the MLK rain crust with the rocks sheeting the deluge of water off itself during the MLK rain event, preventing the rain crust from “bridging” the snowpack over the rocks and neighboring depth hoar.

The winter of 2010/11 will be one for the steezed out grandkids someday: “I remember when when the slabs were 20' deep, rain fell sideways, Hardesty’s beard was not gray yet, etc. But in hindsight, we all must continue to roll with the punches Mother Nature throws, because, in retrospect, without this rain event, the season’s avalanche story could have been much more of a nightmare.

After spending the last four years in the Wasatch tagging along with its characters, getting spoiled by 600” years, and racing Nordic on the U of Utah Ski Team, Ian Havlick now lives amongst the facets in Ophir, CO, where he is an intern for Telluride Helitrax. In the summer Ian loves to tickle trout on any Western trout stream.

A Few Random Thoughts on Crusts from Sam Colbeck

Liam called me a couple of years ago because they had a freezing-rain crust and he wanted to know how long it could last. *(see Ram profile at right)* I did a simple-minded calculation and it looked to be that it would be there all winter. I don’t know how it actually turned out.

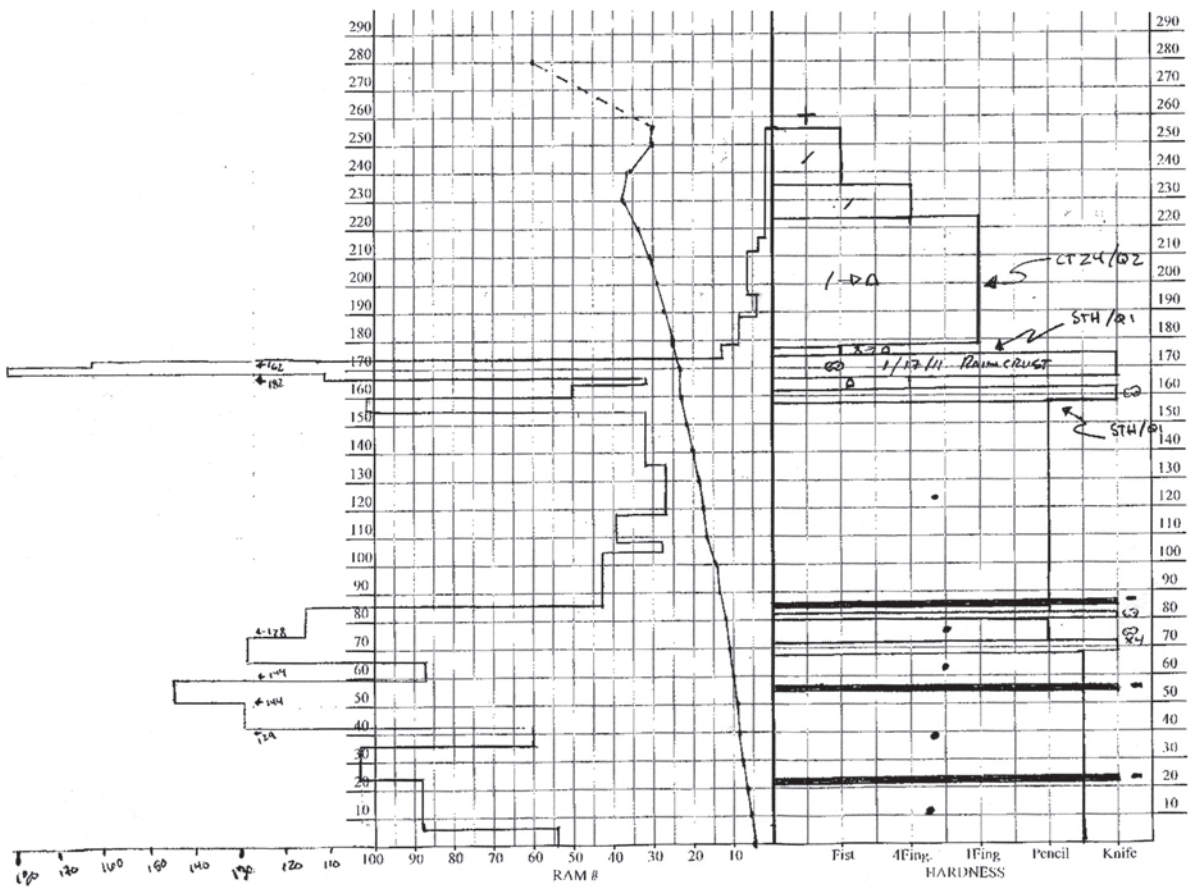
A student once stuck a plastic layer in a cylinder of dry snow to stop vapor flow. The snow had a temperature gradient on it. The plastic increased the vapor pressure on the warm side which led to a strong layer of facets on the warm side of the crusts. We also saw signs of evaporation on the cold side. I had speculated about this for some time and we weren't surprised by the results.

Bruce Jamieson and I once modeled a crust forming because of a wet layer freezing in dry snow. Those layers supply water vapor and cause temperature gradients above the crust so facets grow on the cold side, above the crust.

Looks like you can get facets either above or below a crust depending on the details of the situation. Was your situation a freezing-rain layer or a wet layer that subsequently froze?

A freezing-rain layer is a problem because snow doesn't stick to ice. I can imagine all sorts of results from a wet layer that freezes in place. Just depends on the details of the situation. Hope this helps.

Sam Colbeck



From Rod Newcomb

Here is a ram profile from Little Cottonwood Canyon, taken in mid-February, 2011, sent to Rod Newcomb by Liam Fitzgerald of UDOT, clearly showing a rain event with a high ram # of 182. On January 17, 2011 it rained hard up to 11,000' then froze. Death-defying skiing for a day or two until it snowed again.

Liam's profile of the MLK crust gives us a better idea of the strength of that layer than simply a K for knife hardness. For a good description of the use of the ram go to the latest SWAG and McClung and Schaerer *(2006)*. Study plots using the ram should be a part of local forecasting operations such as ski areas and some highway operations.

The Glory avalanche that hit the bridge was forecasted by our midway ram profile at JHSA.

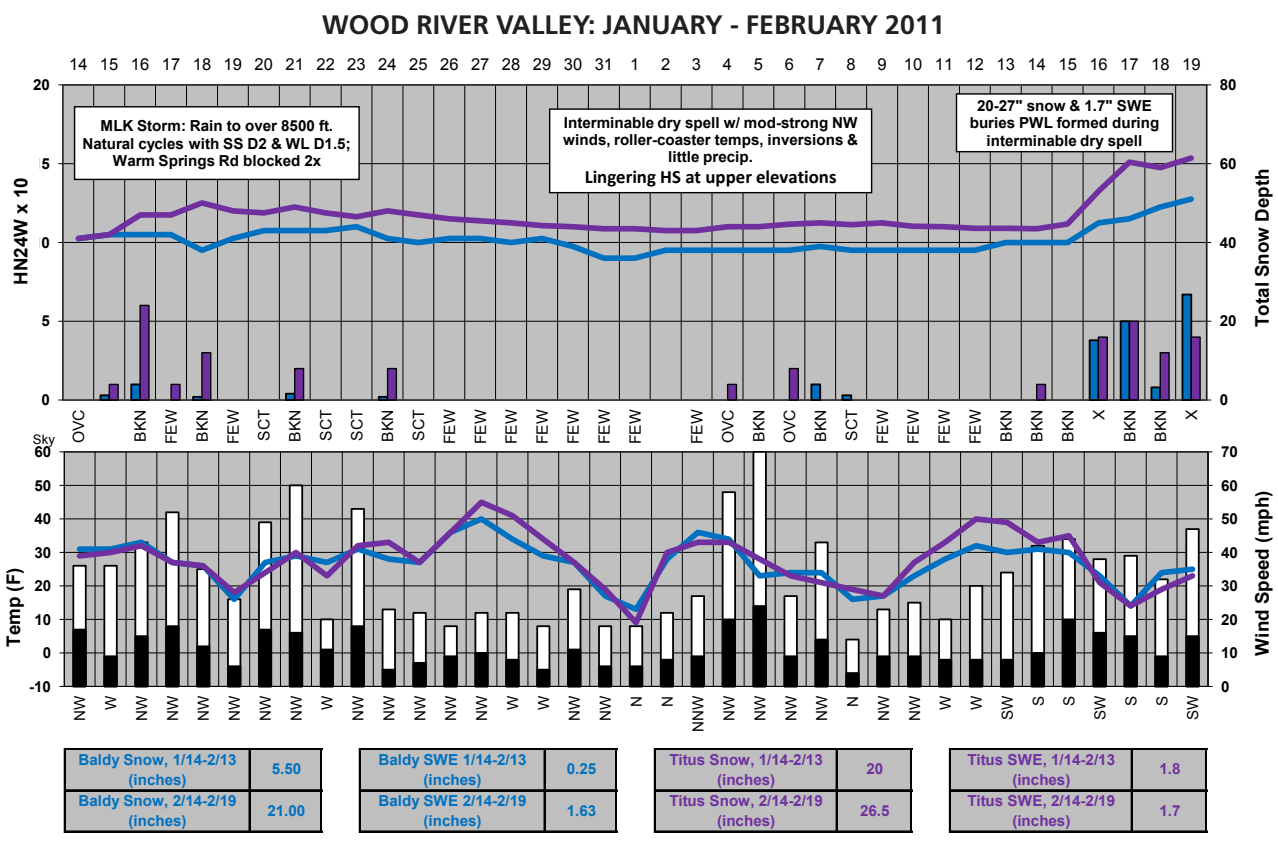
In addition, I did a series of ram profiles earlier this year (on Dec 12 and Dec 23) next to Thanksgiving Bowl off the skied slope. For some reason there was no weakening of the basal layers during that time. And indeed the crown I looked at about a week ago on KB ridge showed that it did not release on the ground, but on a weakness higher in the pack. The ram is a very useful tool for forecasting deep-slab avalanches, particularly in the continental climate.

MLK Crust Effects in SNFAC Advisory Area

Story by Blase Reardon

The Martin Luther King Day storm stands out on weather charts for January, 2011, in central Idaho. It's the most significant weather event of January. It's about the only weather, period. Yet despite its singularity, the MLK event may have influenced subsequent avalanche cycles less than the non-weather that preceded and followed it.

The MLK storm arrived after roughly two weeks of dry and sometimes windy weather. It was a complex storm with varied effects across our advisory area and lasted from Jan 15 to Jan 18. In some places, the warmest temperatures preceded peak precipitation; in others they coincided. The general pattern seemed to be that the northern and western zones received the most moisture – 2-3" of SWE over the period – and had the warmest temperatures, while the Wood River Valley was drier and cooler, especially from Bald Mountain south. Strong northwest winds – 70 to 95mph at ridgelines – accompanied the precipitation and several localized natural avalanche cycles occurred. In the Salmon Headwaters, the rain and wind loading caused numerous small- to medium-sized slabs near the freezing line while the southern zones saw a cycle of natural wet loose avalanches, several of which blocked the Warm Springs Road.



The chart tells the story: 2-7mm rain crust on MLK weekend causes immediate instability as greatest avalanche problem. Then crust stays on the surface down south, covered by 30cm+ farther north, but not to the summits.

The storm's most widespread effect was a vicious crust 2-7mm thick that made backcountry ski conditions downright dangerous. While the crust was nearly ubiquitous, its uppermost elevation and depth below the snow surface were irregular. In the Sawtooth Mountains, this crust seemed to extend almost to the summits of 10,000' peaks. Around Galena Summit, it seemed to reach only to about 8600' elevation – well below summit elevations – but it reached to the summits of the lower peaks further south in the Wood River Valley. In the Salmon Headwaters, it was covered by over 30cm of additional storm snow; in the south Wood River Valley it sat on the surface of a shallow snowpack.

A remarkable dry spell followed, rendering the MLK storm a curiosity. Very little precipitation fell during the ensuing four weeks – just 1.8" of SWE around Galena Summit. It was even drier in the south and central Wood River Valley; the station on Bald Mountain recorded less than 6" of snow and only 0.25"of SWE between January 18 and February 13. Air temperatures bounced from above freezing to near zero and back. Winds were light and northerly except for one blast of moderate to strong northwesterly gusts.

Mid-winter dry spells are common in the SNFAC advisory area – it borders a desert, after all. But that one was interminable. It had striking effects on the surface and near-surface layers of the snowpack. By its end, snow surfaces included old wind slabs, sastrugi, melt-freeze crusts, facets, and even firnspiegel. On sheltered, shady slopes, the near-surface layers faceted, with crystals reaching 2mm or greater in size. Shallow snowpacks faceted to the ground. Small snow events in the northern zones added to the slab above the MLK crust, then these thin layers faceted. In the southern zones, the MLK crust softened and deteriorated on some slopes, but 2-3mm facets formed below it. Local snow workers – SNFAC staff, Bald Mountain Snow Safety, and guides from the three local guide services – grew increasingly alarmed about the developing near-surface weaknesses. The assorted snow surfaces made it difficult to predict any pattern of instability.

On Valentine's Day, our advisory area finally started getting some love: 1.7" of SWE and 20-27" of snow across our advisory area in five days. The stormy pattern continued into mid-April, with measurable snowfall 34 of the next 58 days. The highlight was over 4"of SWE and 45" of snow over nine days in mid-March.

The relentless loading of the snowpack after Valentine's Day caused several memorable avalanche cycles. The first started on February 19 and included natural and remotely triggered slabs to size D3. Collapsing and shooting cracks were common, and Simon and I experienced one slope collapse multiple times. The SNFAC received reports of several close calls in the next week or so, but fortunately no one was seriously injured.

The mid-March storms caused a remarkably destructive natural avalanche cycle in southern Smoky Mountains and Pioneer Mountains, with several additional close calls. One D3 slide deposited over 30' of debris on the Warm Springs Road. Many slides destroyed mature timber, and several created entirely new avalanche paths in the drainages around Bald Mountain.

These avalanches ran on persistent weak layers of faceted snow that formed in the near-surface layers during the interminable dry spell. The MLK crust may have exaggerated faceting during the dry spell, particularly where it was at or within 10cm of the snow surface, such as in the south Wood River Valley. Evidence that supports this idea includes the fact of widespread instability on what appeared to be a relatively uniform weak layer despite the highly variable snow surfaces that existed prior to February 14. Yet many slides started at elevations above the highest elevation of the crust. Even though it's hard to puzzle out these inconsistencies, it's clear that the interminable dry spell would have created persistent weak layers regardless of the crust's existence, so we don't see the MLK event as the culprit in the lingering instability that existed after Valentine's Day. Thus, the 2011 January-February occurrence stands out more than the MLK storm as the dominant mid-winter weather event in the mountains of central Idaho.

Blase Reardon is a forecaster at the Sawtooth NF avalanche center and publications chair for the AAA board. He promises that he will indeed finish his masters before summer.

2011 MLK Rain Event:

Payette Avalanche Center

Story & Photo by Dave Bingaman

A dust layer on the MLK crust shows up well in the pits, consistently pointing to the bad guy below.

The persistent weak layer that plagued the west central mountains last winter started on January 16 with a high-elevation rain event and subsequent cold front that put down between 1-2.5cm of SWE across our forecast area in a 24-hour period. Temperatures climbed as high as 4.1C in the upper elevations then plummeted to -16C in the following 24 hours.

Late January provided a gradual loading of lighter density snow on top of the rain crust mixed with periods of warm days and cold clear nights. High pressure persisted through the middle of February with only a few minor accumulations. The snowpack above the crust layer continued to facet for nearly three weeks under near-perfect conditions. High west winds sometime around Feb 13 deposited a thick layer of dust on the snow surface which became the marker for the upper edge of the MLK crust facet problem layer. By Feb 16 winter had returned with high winds and overnight accumulations of 20-33cm at local Snotel sites. Over the next 48 hours, an additional 60-90cm of snow was added to the top of the older faceted snow above the MLK crust. This loading resulted in a widespread natural avalanche cycle and several human-caused avalanches over a three-day span. Reports of skier- and snowmobile-caused slides filled our inbox and culminated with a close call involving a sidecountry skier near Tamarack Resort and a partial burial a week later in the same area. The faceted layer had by now been compressed to a 5-7cm thick layer of large (1.5+mm) cohesionless crystals. By Feb 25 the slab overlaying the MLK PWL had grown to over 150cm thick. Skiers and cornice bombs were no longer affecting the layer at this point. In the northern portion of our forecast area where less rain had fallen in January and the crust was thinner, the weak layer began to decompose, reducing and almost eliminating the deep-slab hazard.

In our southern forecast area snowmobilers did affect the MLK layer and two sledders were partially buried in separate areas at the end of February. The first week of March was characterized by high SW winds and moderate accumulations over several days and ended with a full snowmobile and rider burial (non-fatal). Our southern area had a much thicker crust which showed no signs of breaking down and continued to produce large, dense avalanches up to 1.5m deep which ran full path and had very high destructive effects throughout the end of our forecasting season. Luckily the areas that preserved the crust and facet interface through April were areas that see relatively little recreational traffic, and we experienced no more human-caused incidents.

Dave Bingaman is keeping the Payette Avalanche Center chugging along. As we go to layout, a series of wet, windy, warm storms is overloading a weak faceting base in his forecast area. We wish him luck with convincing his riders to dial it back.

Two Teats and San Joaquin Mountain lie along a miles-long ridge along the Sierra Crest connecting Mammoth Mountain and June Mountain ski areas. This photo was taken on February 28, 2011. *Photo by Dick Erb, June Mountain ski patrol*

California Crust: East Sierra

Story by Sue Burak

The MLK crust was a real sleeper here in terms of a sliding layer for avalanches. When the January dry spell ended, the mid- to high-elevation crust was faceted or had ice crusts depending on aspect. A multi-day storm dropped between 6-8" SWE in six days with a notable 3" of water falling February 26-27. On February 28, a D4 had occurred on the northeast slopes of Two Teats Mountain *(see photo above)*. We assumed the clean sliding layer was the MLK crust, but we didn't get out to field check before the next storm arrived. Otherwise, there were no observed slides on the MLK crust. Doesn't mean there weren't any, since the forecast area is way too large and the number of observations far too limited to feel confident this was the only slide.

What is of most interest is that the MLK layer did not become reactive until June, when snowmelt finally reached the MLK layer – now under 2-3m of snow. Active wet slab cycles, D2s and D3s mostly with an occasional D4, occurred at the 10-12,000' elevation in the northern part of Mono County where the snowpack was deeper than 2-3m.

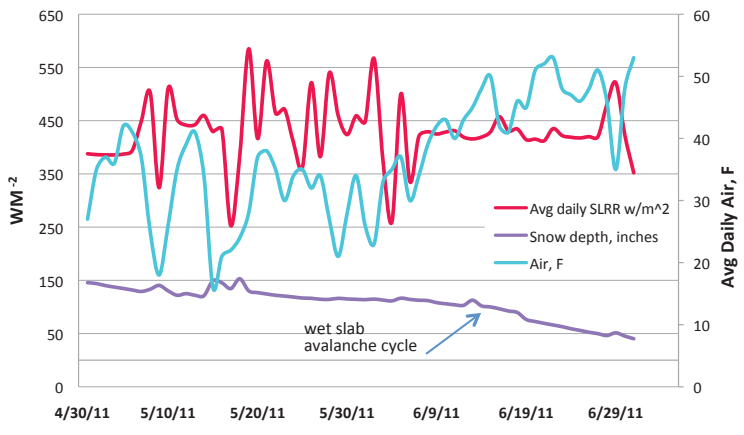
I was surprised that, despite being loaded with 6-8" of water and wind at the end of February, there was not a widespread avalanche cycle after that first storm. Heavy precipitation continued in March, and heavy loading during this time did not result in deep avalanches occurring on the crust. The take-home lesson for me is this: I can't assume the snowpack is inherently strong just because this layer did not react to the rates of precipitation intensity – it was not enough at the right time and in the right places.

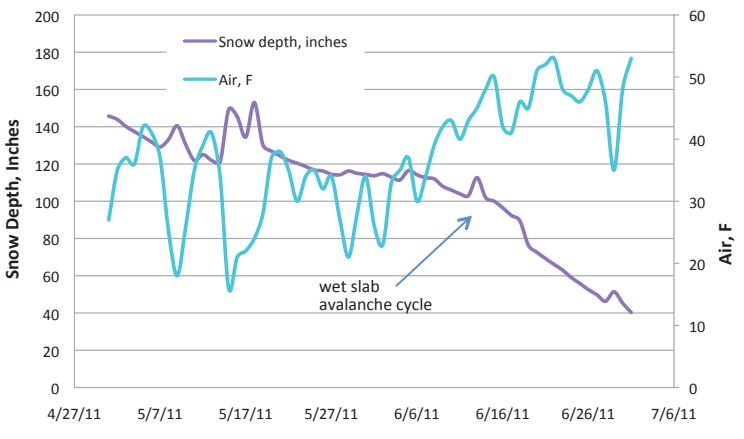
I plotted temp, RH, and net solar radiation *(see charts at right)*. The wet slab activity started once the net solar radiation went from negative (clouds and snowy weather, average temps below 0C) to positive – within three days. Pretty cool and compares favorably with wet snow activity patterns here.

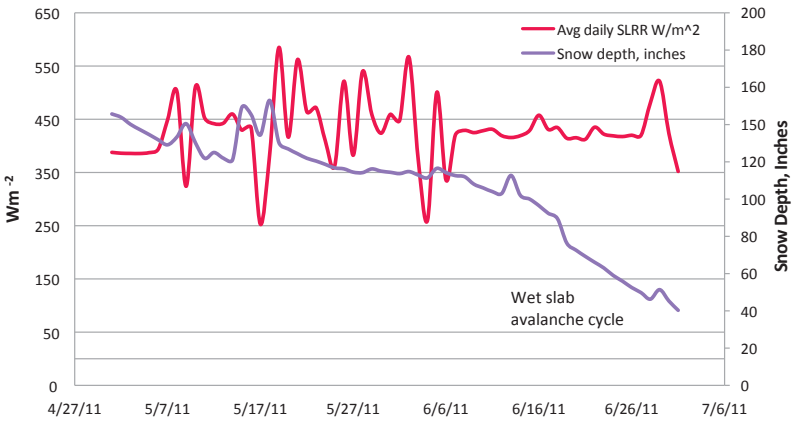
The overall air temp for the Sierra this winter (Dec 1 to March 31) was -4.5C ,so if one uses Karl Birkeland's avalanche climatology flowchart, most sensor locations in the Sierra were classified as Intermountain based on air temp. There was less than 5cm of rain which Karl uses as the main indicator of maritime vs Intermountain climates.

However, even when we get an Intermountain classification, I have not observed Intermountain avalanche activity, probably because the Sierra is usually near the temp cutoff between Intermountain and maritime. There are facets that react in instability tests but even the loading that occurred wasn't enough. I remember talking to Craig Gordon and asking, "How much can this layer take?" Obviously a lot – until snowmelt plus June radiation got to it.

Sue Burak is the avalanche forecaster at the Eastern Sierra Avalanche Center.







ABOUT THE GRAPHS

Below normal May and early June temperatures with snowfall on May 15 (12-15") and another 8-10" on May 17. Clouds, snow and cold temperatures end in early June. Clear skies, rapid warming and night time lows in the 40s begin June 9. Wet-slab cycle begins after four nights of 40F lows.

Snowpack depths at the Tioga Pass remote station were around 100cm. Backcountry snowpack depths in north-facing terrain above 10,000' were 150-250cm with the MLK crust buried 100-200cm down from the surface. Wet-slab crowns were around 1m deep.

Up until the second week of June, the deep snowpack on high elevation north slopes was not quite isothermal with the top 30cm ranging from -0.5C to -1C. Once snowmelt reached the MLK layer, natural wet-slab cycle ensued for three to five days.

NAS HISTORY

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a promising research path for many others to follow. Malcolm Mellor from US Army CRREL lent prestige to our small symposium with his talk on "Controlled release of avalanches by explosives." These papers were compiled into a USFS Technical Report. It was like a baby that would grow up to be an ISSW.

The Move to Seattle…and Back Again to Reno

Northwest avalanche muscle asserted itself. The next NAS, November 1973, was moved to Seattle. Presentations were again based on *The Avalanche Handbook* format, but much was happening on the sidelines. Meetings were called by special interest groups. In those pre-ISSW years the NAS was the place to brainstorm, the place to exhibit the growing avalanche commercialism.

Summer of 1974 I moved to Canada, so Knox Williams organized the 1974 NAS, and it was moved back to Reno – very fitting since Knox was peerless at craps and other games. Of course my recollections from 40 or more years ago have to be amended by others who were present. Judson reminded me that panel discussions were an important part of the NAS. Panels helped break the monotony of lectures, allowed students to hear several opinions, and functioned as a question-and-answer period. Some student questions were easy to answer; to some we should have returned the same empty stare we often observed in student eyes. Instead we fumbled a response. Judson remembered being asked about, of all things, Brownian motion.

The one I remember but would like to forget was the question thrown first to Martinelli: "Why does snow have hexagonal symmetry?" Martinelli answered, "It has to do with the structure of ice. Ron, why don't you explain it." So I went to the board and started drawing incorrect molecular diagrams. Then someone from the audience politely interrupted me: "Ron, hold on, I work with chemistry, let me do this." So he went to the board, erased my diagrams, and drew the correct molecular structure of ice, showing the hexagonal symmetry. Then someone else from the audience asked, "Is this an avalanche school or a chemistry class?"

At one or more schools the students assembled into smaller discussion groups to follow up auditorium presentations – in fact just as in college after the chemistry lecture. Non-lecture activities helped keep the students awake after lunch. Hotchkiss passed around a NASA test given to astronauts to simulate leadership under stress. It was fun even if we weren't sure how it fit into the rescue presentations assigned to the NSPS.

Sandy Bryson was a lead rescue instructor. She walked in and out of the auditorium with her well-trained German Shepherd, introducing us to the concept of the multipurpose rescue dog – more practical than our narrow concept of the avalanche dog.

The Only Rule of Thumb

I wrote a play called *Rules of Thumb* about backcountry safety. The script called for a novice backcountry ski tourer (Perla) to seek advice from the experienced snow ranger (LaChapelle). After each piece of key advice, Hotchkiss would ring a bell and give a "rule of thumb." It turned into a farce, ending my brief playwriting career. Feuchter could have used more instructor depth for the first Reno school. Atwater lived uphill from Reno, was available, and would have loved to help. He was not invited, an eternal blemish on the first NAS. Bill Hotchkiss, Pete Thompson (NPS), and Ron Perla rectified that injustice by arranging a separate 1973 symposium in Yosemite to honor Atwater when he turned 70.

AAA Inspiration

The next schools had a larger instructor pool to tap. Much of the new blood worked with LaChapelle in the San Juans and the Northwest, although one of the best, Art Mears, seemed to appear from nowhere. Neither LaChapelle nor Martinelli could say, "That's my boy." It was impossible to sleep through a Mears's presentation. Judson remembers Mears bouncing a ball on the stage as he explained the complicated subject of avalanche dynamics. A distinguished student was Barry Voight, geology prof from Pennsylvania State University and older brother of Jon Voight (for non-Midnight Cowboys: Angelina Jolie's uncle). However, Barry Voight was famous in his own right as editor of major volumes on rock slides and avalanches. Earlier, he drafted Mellor and Perla to contribute chapters on snow avalanches, then decided to enroll a couple of times in the NAS as he became more interested in snow-avalanche phenomena.

Barry observed almost at once that our group could benefit from a professional organization. Sue Ferguson paid close attention; she was thinking the same. Barry and Sue really hit it off. I remember them walking together, throwing ideas back and forth. A special meeting was called (at the Seattle NAS, if I recall correctly). Sue and Barry made a strong case for the soon to be AAAP.

I vaguely remember Martinelli coordinating NAS phases II and III. I will never forget when Juri Krisjansons visited the Station to discuss his phase II and III contract. Juri was in and out from the station, lightning fast. When he briefly passed my office, I said, "Here I am in a cushy, secure office." Juri replied, "I feel more secure working outside."

A Vision Ahead of its Time

Going back to near the beginning when Feuchter visited the AASC in its twilight to show me his report and explain his proposed three phases of avalanche training, I remember thinking, "There goes my world. We did it all at Alta for 20 years. What he's proposing doesn't make sense." Today I'm thinking maybe Feuchter was ahead of his time.

He could see it coming. Avalanche training would evolve into something truly national.

Ron Perla lives in Canmore, BC, where he is still as smart as he ever was. He reports that, as of mid-December, Canmore was so icy that he needed crampons to get to his mailbox.