SOUTHCENTRAL ALASKA'S CRACK PROBLEM: A 2015/16 GLIDE AVALANCHE CASE STUDY

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ABSTRACT: Along the Seward Highway corridor in Southcentral Alaska, the winter of 2015/16 was defined by a profound and active glide avalanche cycle. Persisting the entire season, the cycle produced an uncountable number of glide cracks and over 100 documented glide avalanches. Local old time avalanche professionals had not seen a season quite like this before. The winter was characterized by above average temperature and above average snowfall. An Arctic outbreak was not experienced all season, which is atypical for the region. After December 24th, the temperature never dipped into the single digits and over 50" of SWE was recorded. This unprecedented glide avalanche cycle affected public backcountry avalanche forecasting (over 100 days in the advisory), closed the premier North Face terrain at Alyeska Resort and even gave the Alaska Department of Transportation (AK DOT) cause for concern. How does one make daily operational decisions, or fight message fatigue in public forecasts, for what is essentially an "un-forecastable" avalanche problem? As a group of practitioners from the Chugach National Forest Avalanche Information Center, Alyeska Resort and AK DOT, we discuss these challenges and measures taken. In addition, we have gathered a large volume of weather and snowpack observations with photo and video documentation to investigate and illustrate the evolution of the glide season. We hope to offer some insights into what we learned as well as possible avenues for future glide studies.

KEYWORDS: glide avalanches, Alaska, operational decision-making, message fatigue

1. INTRODUCTION

Glide avalanches are not a new or unusual phenomenon in the eastern portion of Southcentral Alaska. However, the winter of 2015/16 was remarkable as a nearly continuous glide avalanche cycle lasted the entire season. Among an uncountable number of glide cracks, there were over 100 glide avalanches documented on 62 separate days between January and May. Historical records, old-time Alaskan avalanche professionals and locals were consulted and no similar glide cycles were found or remembered.

Avalanche practitioners from Alyeska Resort, Alaska Department of Transportation (AK DOT) and the Chugach National Forest Avalanche Information Center (CNFAIC) came together to pool our thoughts and data on this unusual winter. This unprecedented glide cycle resulted in an extended closure of the premier North Face terrain at Alyeska Resort, raised heightened concern for motorists along the Seward Highway, and affected public backcountry avalanche forecasting and messaging. Looking at this winter from an operational forecasting perspective, a few interesting questions arose. How does one make daily operational decisions, or fight message fatigue in public forecasts, for what is essentially an "un-forecastable" avalanche problem? How do you convincingly convey a hazard that is not well understood by professionals to the public or management?

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2. BACKGROUND

All three of our operations are located along the Seward Highway corridor South of Anchorage, Alaska and include parts of the Northern Kenai Mountains and Western Chugach Mountains (Fig. 1). Winter seasons tend to vary greatly in precipitation and temperature and it is common for the rain/snow line to fluctuate from sea-level to ridge-tops creating high variability in the snowpack with respect to elevation. Truly the “land of extremes”, the region also sees unique micro-climates, for example, continental snowpacks sit roughly 15 miles from maritime snowpacks (Wagner, 2012). Furthermore, solar impacts at 61 degrees North are minimal from November through February, until the sunlight returns rapidly in March and April. Despite this, winters more often than not begin warm and wet and these seasons tend to be the years with the most glide activity. Typically cycles occur during the early winter and spring. However, occasionally this region will see mid-winter glide cracks and releases.

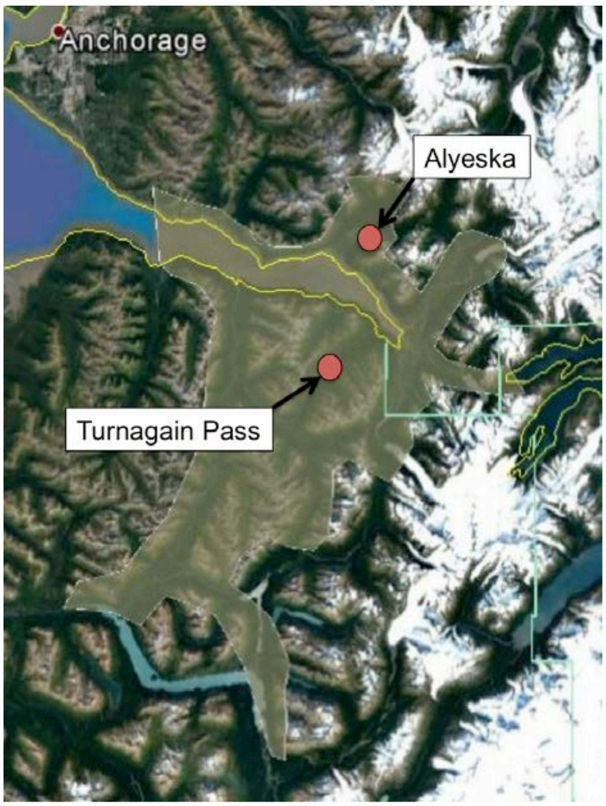

Fig. 1: Shaded area includes the Seward Highway corridor, with Alyeska and Turnagain Pass labeled.

Avalanche starting zones are generally at 2,000-3,500’ feet at Alyeska Resort, 3,000-5,000’ along the Seward Highway corridor and 2,000-4,000’ in Turnagain Pass. With many run-outs descending to sea-level, avalanche paths often harbor dry cold snow in start zones and wet or no snow in run-out zones. For example, Alyeska Resort receives roughly 500-1,000” of total snowfall at the top lift station (2,750’), but only 100”-300” of snowfall at the base area (250’).

The winter of 2015/16 was characterized by above average temperature and above average precipitation, with well below average snowfall in the lower elevations due to heavy rainfall. An Arctic outbreak (cold air from inland Alaska flowing up and over the Alaska Range and Chugach Mountains into Southcentral, Alaska) was not experienced all season, which is atypical for the region. After December the air temperature never dipped into the single digits. At Alyeska Resort over 60” of SWE was recorded at mid-mountain (1,500’), which was consistently the dividing elevation between snow and rain. In Turnagain Pass over 47” of SWE was recorded for the season, and a preliminary look into regional soil temperature suggests no freezing in the upper centimeters.

3. ORGANIZATIONS

3.1 Alyeska Resort

A look at glide cycles in 3 varieties:

We can discuss our glide cycles at Alyeska in terms of how the winter snowpack forms and responds over a winter. Three common glide cycles correspond roughly to the early, mid, and late-winter months. In our dynamic climate, the calendar boundaries of each period are not fixed, and not all cycles occur each winter.

Many of our winters begin with rain and wet snow trying to stick to warm, wet ground. Shallow glide releases are common in October and November, largely before the mountain is open. As winter takes hold and the snowpack cools, these early-season cycles often come to an end within a few weeks, despite the increasing load from more storms.

While new glide cracks sometimes form in mid-winter, actual glide releases in these deeper snowpacks are relatively rare. These cycles seem to favor winters in which a glide-friendly ground interface coincides with a warmer and heavier than normal snowpack. However, the snowpack is not isothermal. Some cycles are short-lived, possibly ending if the snowpack cools or compacts sufficiently to become less fluid. Other cycles continue for months, and are so active that they leave the slope looking like a maze of glacial crevasses. The potential for a high-hazard full-depth release frequently demands long-term terrain closures to manage these most difficult problems. The low incidence of actual release makes the job of selling those closures that much more difficult.

A final cycle of glide releases can occur during the late-spring meltdown in late-April or May. Resembling full-depth wet-slabs with pre-cracks, these high-hazard cycles also demand conservative terrain closures. Their close association with the progression towards an isothermal snowpack may loosely define the time-period for release, but not the likelihood.

Winter 2015/16 in comparison:

Our records for the 15-year period prior to 2015/16 provide a basis for comparison. Occurring in 7 of those winters, we observed 109 glide releases. The vast majority occurred in the early-season; a handful occurred in the late-spring; but only 2 releases occurred mid-winter.

But the winter of 2015/16 was a different pickle. Of the 18 recorded glide releases at the resort last winter, only 1 occurred in the early-season, and only 3 released during the spring meltdown. Far from our typical experience, the bulk of the glide releases occurred as sporadic events within a basically continuous cycle from late-January through late-April.

These unusual mid-winter releases occurred in a deep and warm (but non-isothermal) snowpack, with most crowns averaging 10'-15'. In the 1,700-2,000' mid-elevation band where most releases occurred, the weather from January through March seemed the perfect recipe to promote glide. The freezing level remained within that narrow elevation band consistently. And with an abundance of snow and rain, the average new-snow water content in all 3 months was 16-17%, well above our long-term average of 8-10%. Then, for all of April it just plain rained. In some ways the mid-mountain snowpack in mid-winter resembled a deeper variety of an early-season snowpack.

The first release in January was of a small portion of a large glide crack below the North Face Tram Tower. After that move, it creaked and groaned for a full month, before suddenly lurching forward 30 feet in 6 hours. And then it just stopped. The Facet, another slope on the North Face, experienced 7 separate releases over 4 months, including a size D3.5-R4 deemed the largest glide release in memory at the resort (Fig. 2). And an oddball event: a glide crack on the Headwall appeared from nowhere, when a 7.1 magnitude earthquake ripped a 400-foot wide tear across mid-slope. Glides cracks numbered in the dozens, and spread to most areas of the mountain. Most glides that eventually did release were noticeably moving for weeks or months beforehand. But many other glides also active for months never released.

Operational decision-making:

Terrain management decisions are always a challenge when glides are the problem. Normal forecasting techniques do not apply to glides. They respond poorly to control measures. And they don't even tell you when they're done. The chances of a release may be low, but the consequences are high. Faced with such big unknowns, conservative thinking seems mandatory.

By mid-winter we were already uncomfortable with the state of our mid-mountain snowpack. As new glide cracks began to appear, reports of glide releases in the surrounding region bolstered our concerns. We began to tuck-in and had the North Face closed down completely two days prior to our first glide release at the Tram Tower. The potential hazard was now proven, and we didn't trust any of them.

Over the years we have tried various techniques to release glides with explosives, without real success. Once again we tried, this time shooting five rounds from our 105mm Howitzer into the slab boundary of a problematic glide on the Headwall. We got the expected result - no release.

As we looked for pillars to support our terrain decisions, we developed strategies around a guiding rule: "no exposure below any glides". To be conservative we used pessimistic estimates of run-out potentials. As more glides appeared a distribution pattern emerged, with some areas becoming saturated with glide cracks, while other areas remained intact. "Glide-free slopes tend to remain glide-free (at least for a day)" seemed another good guide. Every effort was made to offer as much glide-free terrain as we could, often by parceling-out terrain with creative but conservative boundaries. Slopes were carefully inspected each morning, with any report of new cracks being a cause for closure (some glides waste no time when deciding to release). Guards were posted along boundaries when activity behind the line increased. When glides in closed areas did eventually release, an immediate boundary sweep was conducted to confirm no involvement. The decision-making continued beyond the ski season and

Fig. 2: A D3.5-R4 glide avalanche occurring on The Facet slide path within Alyeska Resort's prime North Face terrain.

through the post-season maintenance period, until snowmelt had reduced the volume enough to simply remove the hazard.

We pondered on what terms could make us feel comfortable to re-open a closed area. As it went, there was no significant improvement in the character of the snowpack all season. Glide releases continued at the ski area and throughout the region into late May. As such, none of the areas we had closed for glides were ever re-opened. Guests (and some employees) become understandably disheartened with the static nature of such a problem. Providing frequent status updates, with a dose of pertinent education, did help to promote understanding of the situation. Conservative thinking and consistency seemed to pay off, and we made it through a difficult season without incident.

3.2 Alaska Department of Transportation

The glide cycle during the winter of 2016 has been the most active documented glide cycle for the Seward Highway Avalanche Program. During the winter season it is common to see glide cracks and glide avalanches along the Seward Highway transportation corridor. What makes this glide cycle unique is the great concentration and active release of these glides for several months. From March 4 through April 14 there were approximately 44 glide avalanche releases in paths that affect the highway. The majority of these releases occurred along a 5-mile stretch of highway generally with a southern aspect (see Figure 3).

Fig. 3 “92 mile path” winter 2015/16 typical glide avalanche

The winter weather contributed to an above average snowpack above 1,500 feet and a below average snowpack under 1,500 feet. Generally there was no snow on the ground from sea level to 1,000 feet. The avalanche paths along the most active glide avalanche zone consist of complex starting zones. Individual avalanche paths are not easily identified but are instead broken into areas with a path name as the identifier. Many of these avalanche paths have a vertical relief of 3,000 to 4,000 feet. Combine these factors and add in the unpredictability of glide avalanches, lack of mitigation options, and a major transportation corridor; this may lead to problematic avalanche hazard considerations.

Fortunately glide avalanche hazard considerations for the Seward Highway were negligible. Operationally we played the game of “wait and see”. Each individual glide crack and avalanche path was assessed for available snow to entrain, whether the path was confined or open, surface roughness, supported slope at glide location, and destructive potential. With no snow below 1,500 feet many glide avalanches were quickly arrested. Glide avalanches in confined tracks were channeled and several ran 2,500 feet to sea level. However the amount of debris was relatively small in the deposition zone.

Of note was the change in glide avalanche character. The early glide avalanche releases appeared to have started from a cold snowpack with very little free water, evident by the large blocky debris resembling hard slab debris. General observations of glide releases during this period show that there was no identifiable trigger. One particular slope would have a glide crack for several days then adjacent to this crack a sudden release would happen. Timing during the day also played little difference during the March glide releases.

The documentation during the winter of 2016 for glide releases has shown what can be produced under the snowpack and weather conditions. This will undoubtedly aid future glide avalanche hazard considerations in the future.

3.3 <u>Chugach National Forest Avalanche Information Center</u>

As the backcountry avalanche forecasting entity in the region, the CNFAIC has never experienced a glide cycle as prolonged and active as the winter of 2015/16 since its inception in 2001. Producing a daily avalanche advisory product, our staff was keenly aware of and concerned about message fatigue with our readers. Glide avalanches had a mention in the advisory every day from January 7th – April 30th, 114 advisories out of 157 for the season. 44 of those days (38%) glide avalanches were our primary avalanche concern in the core advisory area of Turnagain Pass. The glide avalanche problem icon got some heavy use at the CNFAIC. The majority of glide cracks (precursor to a glide avalanche) appeared in the ‘Treeline’ elevation zone between 1,000’ and 2,500’ in popular backcountry ski and snowmachine terrain. Some large swaths of usually skiable terrain didn’t see any traffic; while backcountry users effectively “played their odds” to access other zones. Several popular travel corridors for skiers and snowmachiners were entirely in the path of overhead glide crack hazards for the majority of the winter.

Our staff experienced the unpredictability of glides firsthand as a magnitude 7.1 earthquake shook our advisory area on January 24th, 2016 with no discernable glide avalanches resulting. However, on a mild evening in April a half dozen snow and avalanche professionals sat at the bar in Girdwood discussing this paper, a substantial glide crack avalanched on the North Face of Alyeska Resort just a stone’s throw from our bar stools! Across the region, glide cracks were observed and reported as avalanching during cold snaps, warm-ups, stormy days, sunny days and overnight on all aspects, slope shapes and multiple elevation bands.

That being said, we also observed cracks that never released and benignly melted out with the inevitable transition into spring and summer.

The public question of "What is a glide avalanche?" and trying to convey the answer with current resources was even a bit of a challenge. One of our prime education tools is the animation section included in the National Avalanche Center Encyclopedia. With a glide avalanche problem not associated with solar effects as the trigger, we struggled to find a conceptual model to help our hungry readers.

Truly a high consequence, low probability avalanche problem, the CNFAIC staff was challenged to communicate this hazard to the public when the snowpack was otherwise generally stable in areas absent of cracks, for example the 'Alpine' above 2,500'. This often made for an *upside down* danger rating with respect to elevation, with Low danger in the 'Alpine' and Considerable at 'Treeline' (Fig. 4). A further challenge to our job was although humans have not been known to trigger glide avalanches, glide cracks themselves are largely ticking time bombs. Thus, the glide avalanche problem did not fit nicely into the North American Danger Scale (Statham et al, 2010). Specifically, when natural glide avalanches were occurring but human triggered avalanches were unlikely. To combat this issue CNFAIC forecasters focused on the travel advice portion of the Danger Scale and used a primary message of avoidance and limiting exposure time under glide cracks. Message fatigue became a big concern. How many times and ways can a forecaster say, "Do not travel underneath glide cracks"? This became even more of an issue by the time April rolled around when the Seattle Ridge up-track, arguably the most popular snowmachine slope in our forecast area, was covered in cracks and glide avalanches were occurring daily on the adjacent terrain. During this time we incorporated aggressive social media posts that specifically warned users that "Travel is Not Recommended on the Seattle Ridge Up-track" (Fig. 5)," it was encouraging to see many people heed the warning.

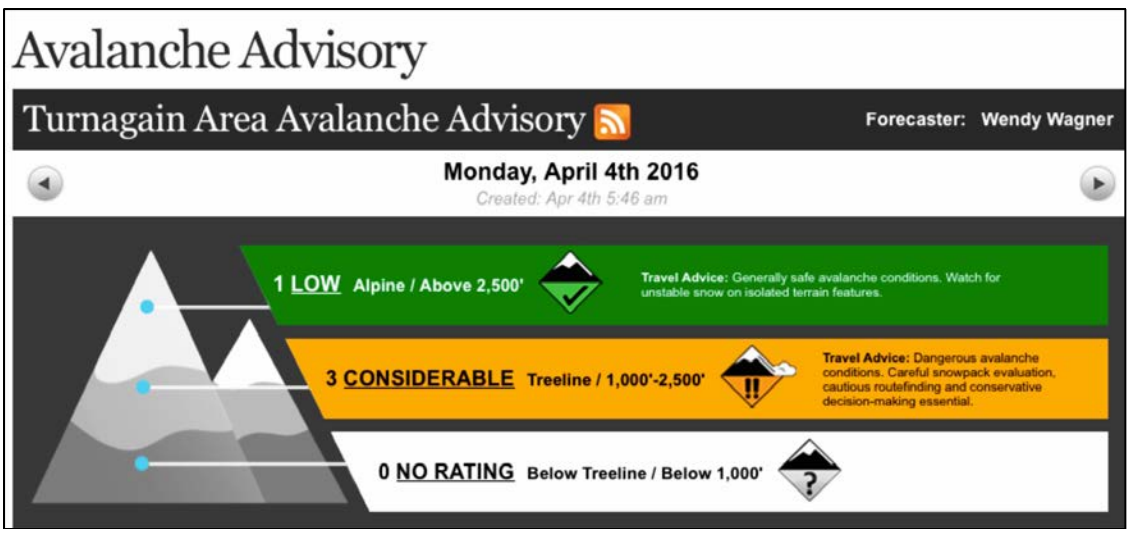

Fig. 4: Upside down danger rating with respect to elevation due to the mid-elevation band glide avalanche danger.

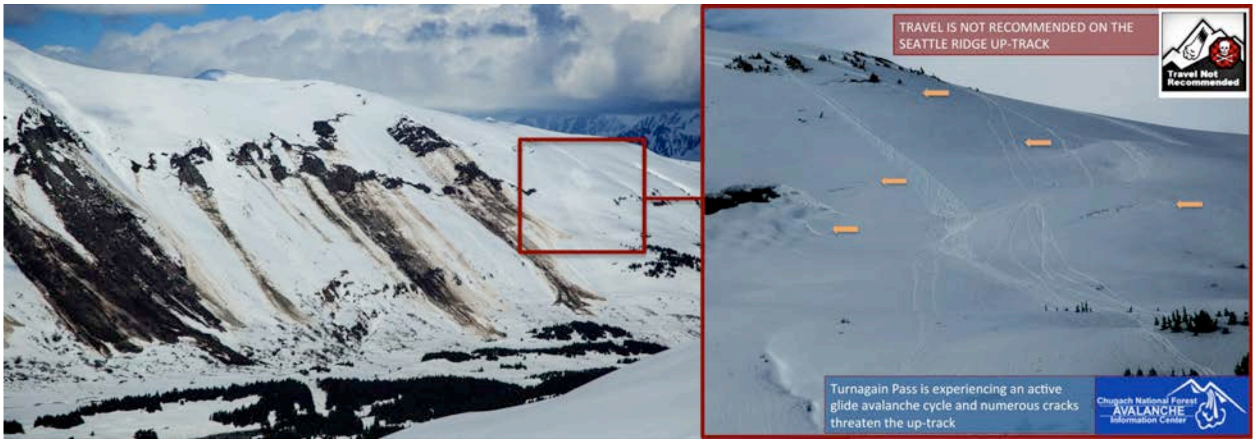

Fig. 5: An example of a CNFAIC social media post that urged backcountry users to avoid certain popular slopes with active glide releases.

We did our best to document the glide activity with notes, photographs and diagrams. Before and after photos were the most effective at visually illustrating the 'unpredictability' of glide releases. However, it was impossible to consistently capture 'before' photos on a daily basis of our entire region due to poor visibility, stormy weather, and 1,000's of acres of terrain not visible from the road corridor. One of the most helpful tools was a time-lapse Road Weather Information System (RWIS) web camera pointed at a slope called "Repeat Offender," adjacent to the up-track mentioned above on the popular snowmachine area of Seattle Ridge. These time stamped images became key in discerning time of release. These were some of the few glide avalanches that we had an approximate time of day when they released. There were a few lucky observers who saw glide avalanches happen and had exact times.

Public observations of glide avalanches were also helpful, yet these too were difficult to determine time of release. Some glide avalanches had multiple reports over many days. In March and April the spring warm-up melted the older glide avalanche slide paths down to dirt. In the winter months dark debris identified a recent glide avalanche, while in spring lighter colored debris over the dark dirt of old glide avalanches identified recent glide releases. Still, we were unable to know the exact time of release for the majority of glide avalanches, making it even more difficult to find a pattern based on daily warming temperatures in the spring.

As an operational forecasting center responsible for providing a daily advisory product we lacked the time, tools and personnel to study or draw any definitive conclusions on how, why or when glide avalanche cycles activated during the past season. However it was heartening to hear local skiers and snowmachiners talking about the glide avalanches with cautionary respect, social media posts getting spread throughout the community and avalanche students questions lingering on the glide avalanche problem. At least in the immediate future glides won't be such a surprise to the public utilizing the forecast if they experienced this winter. The season inspired us all to want to know more and develop better tools to explain the phenomenon.

4. DISCUSSION

After many discussions amongst our organizations, we seem to only raise more questions and no answers. Could the glide activity possibly be split into winter releases and spring releases? How does this compare to the cold-temperature releases vs. warm-temperature releases defined in earlier research (Dreier et al. 2013). And the inevitable question, will Southcentral Alaska have a similar glide cycle or winter like 2015/16 in the future? Chances are maybe and with the current changing climate, possibly more so. Yet, time will tell… What this winter has done is inspired the group to look more closely at past glide research to determine what applies to this region and look to further regional research efforts. We were able to collect a sizeable dataset of glide activity spikes to compare with air temperature, precipitation, sky cover, snowpack and soil temperature, photos and general observations. We hope to utilize this for further collaborative research efforts to better understand this phenomenon, especially in these dynamic snow climates of Southcentral Alaska. If there is another season like this one we hope to use time-lapse photography, collect more detailed ground/snowpack interface data, target different weather data and look more closely at terrain characteristics. We will continue to work on improving ways to communicate this unique avalanche problem to the public and will look into developing more pertinent educational tools.

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