ALL-WEATHER AVALANCHE MONITORING: RAPID RADAR DEPLOYMENT SUPPORTING DECISION MAKING IN JUNEAU

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ABSTRACT: The city center of Juneau, Alaska, lies between the sea and steep mountain terrain, with several neighborhoods located in avalanche runout zones. During the December 2025–January 2026 winter storm, record snowfall combined with sustained cold temperatures created extreme avalanche hazard conditions across coastal South Alaska. The City and Borough of Juneau issued evacuation advisories for exposed neighborhoods, while continued snow- and rainfall further increased the hazard. A State Disaster Declaration enabled rapid access to state and federal support. As part of the emergency response, a Doppler radar system for real-time avalanche detection was procured, delivered, and installed within 48 hours. Positioned across the fjord, the system monitors multiple avalanche paths at distances of up to 3 km. The radar operates continuously, independent of visibility conditions, providing reliable detection during storms, snowfall, darkness, and low cloud cover — periods when conventional observations are severely limited or not possible.

The system automatically detects avalanche events and provides real-time alerts, including location and event metadata, via a user interface accessible to avalanche professionals and emergency managers. Each detection is synchronized with video from an integrated camera, allowing users to review events and validate radar signals when visibility permits. This combination of continuous detection and visual confirmation supports both immediate situational awareness and retrospective analysis.

Operationally, the radar proved particularly valuable during periods of no visibility, enabling practitioners to track avalanche activity in real time and adjust hazard assessments accordingly. This improved confidence in decision-making related to evacuations, road safety, and public communication. The system also provided insight into avalanche frequency, timing, and spatial distribution across monitored paths.

KEYWORDS: avalanche radar, Doppler detection, urban avalanche hazard, evacuation decision-making, Juneau, Alaska

1. INTRODUCTION

Juneau, Alaska's capital, occupies a narrow shelf of land between the Gastineau Channel and the steep, avalanche-prone slopes of Mount Juneau. Several downtown neighborhoods lie within mapped avalanche runout zones. The Behrends avalanche path, which starts in an approximately 60-acre snowfield near the summit of Mount Juneau, is one of the most consequential of these paths: roughly two-thirds of the homes on the 200 block of Behrends Avenue were built in 1950 alone, directly in its runout zone, during a period of acute post-war housing shortage and despite city records already flagging the area as a possible slide zone. Documented events in 1890, 1917, and 1962 (a soft-slab avalanche that damaged more than 30 homes) show that major releases occur roughly every few decades. A 2011 hazard assessment concluded that the risk to residents was "unacceptable," noting that a large avalanche could level the neighborhood and that no active mitigation measures were in place (KTOO, 2021).

2. RECORD SNOWFALL AND STATE DISASTER DECLARATION

This risk materialized during the winter of 2025–2026. Juneau recorded its snowiest December on record, with 79.8 inches measured at the airport by December 31, surpassing the previous record of 54.7 inches set in 1964 — including 40.6 inches over just a few days that Christmas weekend (Juneau Empire, 2025). Sustained cold temperatures combined with this exceptional snow load to raise avalanche hazard to extreme levels on the Mount Juneau, Gastineau Avenue, and Thane Road paths. The City and Borough of Juneau (CBJ) issued avalanche advisories and road closures beginning December 30, and a State Disaster Declaration, approved by the Governor, unlocked state and federal support for the response.

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Through early January 2026, CBJ issued a series of evacuation advisories as conditions evolved: a new alert for the Behrends, White, and Thane Road areas on January 5; confirmation on January 9 that multiple small avalanches had released above Behrends and along Thane Road, prompting evacuations to the Centennial Hall shelter — the same facility used during a previous Behrends evacuation (CBJ, 2021; Alaska Public Media, 2026); and, by January 12, the lifting of all advisories except for the Behrends path, where a large, undisturbed pocket of snow remained near the starting zone and continued to threaten homes along Behrends Avenue and Judy Lane (Figure 1; Juneau Empire, 2026). Because darkness, low cloud, and continuing storms repeatedly prevented avalanche professionals from visually confirming whether this pocket had released, the evacuation advisory for Behrends stayed in effect for several additional days after every other zone had reopened.

Figure 1: Overview of Behrends avalanche path on Mount Juneau.

To close this observation gap, CBJ procured a Gravimon Doppler radar system (KTOO, 2026a) — an industrial-grade, all-weather radar purpose-built for avalanche detection. The unit was delivered and installed within 48 hours at the AEL&P substation on Douglas Island, positioned across Gastineau Channel roughly 3 km from the monitored slopes (Figure 2). The complete system, including delivery, installation, and operation, cost nearly USD 200,000. The deployment builds on experience from earlier Gravimon and Geoprevent Doppler radar installations for infrastructure and road protection in Switzerland, Norway, and the United States (Stähly et al., 2023; Stähly et al., 2024; Farrér et al., 2024).

Operating continuously and independent of visibility, the radar tracks avalanche location, extent, and speed in real time, synchronizes each detection with video from an integrated camera, and pushes alerts to avalanche professionals and emergency managers through the GraviApp.

Figure 2: Gravimon avalanche radar and PTZ camera, installed at the AEL&P substation on Douglas Island, monitoring the Behrends path on Mount Juneau.

3. DETECTION RESULTS AND OPERATIONAL SUCCESS

Following the radar's installation on January 11, no avalanches were detected — contrary to expectations — giving forecasters confidence that all release zones had unloaded. The evacuation advisory for residents in the runout of the Behrends path was officially lifted on January 15, 2026 (KTOO, 2026b).

It then took more than a month, until the next significant snowstorm, for the radar to detect its first avalanche on the monitored paths, on February 17. Over the remainder of the winter, the radar automatically detected, recorded, and 3D-mapped a total of 77 avalanches. Figure 3 presents a screenshot of the GraviApp, with an event list on the left side. For the selected event, recorded details are displayed: event video on the left, visualization on the right with trajectory and echo point view, and event data at the bottom (run length, start elevation, terminus elevation, duration, speed). A time bar at the bottom of the screen allows the event to be replayed and navigated. Color coding on the right marks the radar viewshed, with yellow indicating high radar power that decreases toward blue, showing that the radar covers a wide range of avalanche paths on Mount Juneau. The viewshed also reveals areas of terrain shadow that are not visible to the radar. This detection record also supports the kind of model-validation and operational-forecasting applications recently demonstrated by combining radar detections with avalanche forecast models (Trachsel et al., 2024).

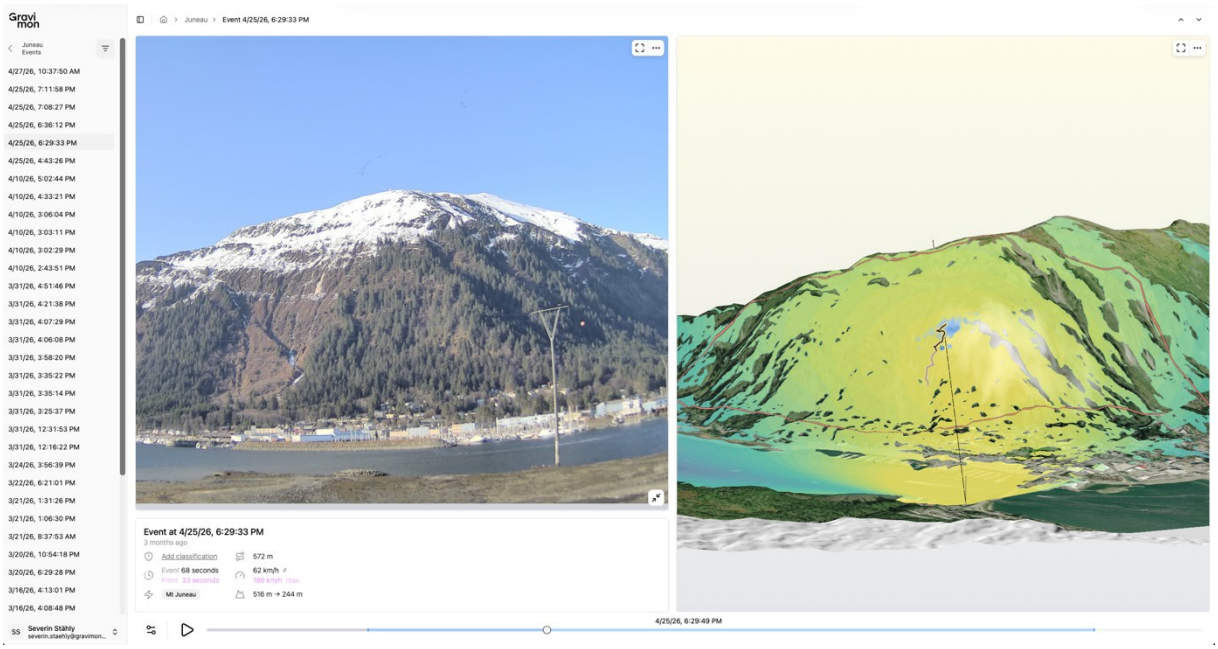

Figure 3: GraviApp view of the situation. Event video on the left, 3D avalanche mapping on the right, event information below the video and a time bar to animate the video and map.

4. CONCLUSION

This case study demonstrates that a rapidly deployable, all-weather Doppler radar can meaningfully strengthen avalanche response in maritime climates such as Southeast Alaska's, where storms, darkness, and low cloud routinely close the window for conventional visual observation. Delivered and installed within 48 hours of being procured, the Gravimon avalanche radar provided continuous, real-time detection across multiple paths on Mount Juneau for the remainder of the December 2025–January 2026 event, filling exactly the gap that had previously left the Behrends path's evacuation advisory dependent on visual confirmation that conditions rarely allowed.

For the City and Borough of Juneau, the practical value of this capability was most apparent during the extended Behrends advisory. Rather than relying solely on intermittent ground observations, CBJ's emergency management team could monitor the undisturbed snow pocket near the starting zone directly, cross-check radar detections against synchronized camera video, and communicate hazard status to residents with a level of confidence that had not previously been possible during storm conditions. This shortened the periods of uncertainty that, in past events, had kept advisories in place longer than strictly necessary, and gave decision-makers a clearer evidence base for both extending and lifting evacuation orders.

The same radar coverage extends well beyond the Behrends neighborhood, directly benefiting the study's other partner agencies. The Alaska Department of Transportation & Infrastructure monitors avalanche activity on the Thane Road corridor within the radar's field of view, supporting its own closure and reopening decisions on that highway with the same real-time, all-weather detection. Alaska Electric Light & Power Co. gains similar value on monitored paths that cross one of its transmission lines, where continuous radar coverage offers early warning of avalanche activity that could otherwise damage infrastructure or interrupt power supply before a visual inspection would even be possible. Based on this combined value across emergency management, transportation, and utility operations, CBJ will keep the radar permanently in place on Douglas Island as a standing component of its urban avalanche program, providing continuous monitoring of the Behrends and neighboring paths in future winters.

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REFERENCES

Alaska Public Media, 2026. Multiple small avalanches release in Juneau after city issues evacuation advisory, 9 January 2026. https://alaskapublic.org/news/public-safety/2026-01-09/multiple-small-avalanches-release-in-juneau-after-city-issues-evacuation-advisory

City and Borough of Juneau (CBJ), 2021. CBJ recommends residents in Behrends Ave. avalanche path to evacuate; evacuation center at Centennial Hall opens at 8 p.m. tonight. Juneau, AK. https://juneau.org/newsroom-item/cbj-recommends-residents-in-behrends-ave-avalanche-path-to-evacuate-evacuation-center-at-centennial-hall-opens-at-8-p-m-tonight

Farrér, A., Pettersen, S.U., Wahlen, S., Stähly, S., Carrel, M., Schoch, T., Walberg, N.A.K., 2024. Avalanche radar system monitoring avalanche paths endangering road at Bjærangen, Norway – implementation of new trajectory algorithms for improved detection accuracy, visualization and reduction of false detection, in: Proceedings, International Snow Science Workshop, Tromsø, Norway, 1115–1118.

Juneau Empire, 2025. Warnings pile up under record-breaking snowfall in Juneau, 31 December 2025. https://www.juneauempire.com/2025/12/31/warnings-pile-up-under-record-breaking-snowfall-in-juneau/

Juneau Empire, 2026. Evacuation advisory in effect for Behrends slide path, all others lifted in Juneau, 12 January 2026. https://www.juneauempire.com/2026/01/12/evacutation-advisory-in-effect-for-behrends-slide-path-all-others-lifted-in-juneau/

KTOO, 2021. How a Juneau subdivision came to be at ‘unacceptable’ risk for a destructive avalanche, 22 June 2021. https://www.ktoo.org/2021/06/22/70-years-behrends-avalanche-path/

KTOO, 2026a. Mount Juneau gets new radar avalanche detection system as Behrends path remains under evacuation advisory, 12 January 2026. https://www.ktoo.org/2026/01/12/mount-juneau-gets-new-radar-avalanche-detection-system-as-behrends-path-remains-under-evacuation-advisory/

KTOO, 2026b. Residents in avalanche zones return home after Juneau clears last evacuation advisory, 14 January 2026. https://www.ktoo.org/2026/01/14/residents-in-avalanche-zones-return-home-after-juneau-clears-last-evacuation-advisory/

Stähly, S., Yount, J., Gorsage, B., Greene, E., Wahlen, S., 2023. Optimizing road management with Doppler radar for automatic avalanche detection at I-70, in: Proceedings, International Snow Science Workshop, Bend, Oregon, USA, 1565–1568.

Stähly, S., Carrel, M., Hahner, M., Fellay, F., Carlen, N., Sierro, P.-A., Bumann, S., Mayoraz, P., 2024. Avalanche detection and RACS blasting verification using extra long-range Doppler radars: experience from Saas-Fee and Evolène, Switzerland, in: Proceedings, International Snow Science Workshop, Tromsø, Norway, 1137–1141.

Trachsel, J., Richter, B., Stähly, S., Mayer, S., Wahlen, S., van Herwijnen, A., Techel, F., 2024. Combining model predictions and radar avalanche detections for operational avalanche forecasting, in: Proceedings, International Snow Science Workshop, Tromsø, Norway, 23–29.