

FROM POINT TO SLOPE: ASSESSING WEATHER STATION SNOW DEPTH REPRESENTATIVENESS USING LIDAR AND GEOSTATISTICS

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SPEEL ARM, ALASKA

Maritime snow climate; wet, windy storms.
Fluctuating rain-snow line throughout winter.
Strong outflow winds from the N-NE.
Powerline traverses steep avalanche chutes.
Two weather stations with Sonic Ranging snow sensors (“Balcony” and “Diverter 4-4”).

SNOW DEPTH MAPPING USING AERIAL LIDAR

- 1 ‘snow off’ and 6 ‘snow on’ lidar surveys
- Coregistration and accuracy assessment
- Raster algebra to derive snow depth

GEOSTATISTICAL ANALYSIS

Elevational snow depth gradient based on lidar-derived snow depth and averaged for 10 m elevation bins across the study area.
→ Snow depth increase consistent up to 600 m asl; up high variable due to wind effect (Figure 2).

Interannual late-season snow retention patterns using *Unsupervised Iso Cluster Analysis*.
→ Avalanche activity, aspect and elevation affect snowpack duration and variability.

Spatial scaling of snow depth around weather stations to analyze representativeness.
→ 4-4 Diverter station is more representative than the Balcony station at 25 m buffer radius. With larger zones snow depth variability increases.

Station-measured vs. lidar-measured absolute snow depth at weather stations.
→ Moderate agreement with some large (< 2 m) discrepancies near peak snow depth.
→ Could there be an influence of the height of the Sonic Ranging sensor affecting measurements?

Predictive skill – *Can we use station-recorded snow depth to predict mean snow depth in nearby avalanche starting zones?*
→ Our simple distance-weighted model shows poor correlation (Pearson r: 0.166, p-value: 6.062e-01, R²: -8.403, RMSE: 2.556 m, Bias (Pred - Obs): -2.242 m, MAE: 2.298 m).
→ Diverter 4-4 station reports snow depth reduction while 4-4 and 4-3 starting zones report increasing or stable depth.

Similarity analysis for weather station placement
→ Analysis based on snow depth *change* recorded at Diverter 4-4 station vs. mean snow depth *change* in avalanche starting zones.
→ We provide a map that can assist identifying locations for future weather stations (Figure 1).

Where could a weather station be placed to capture snow depth changes in nearby avalanche starting zones?

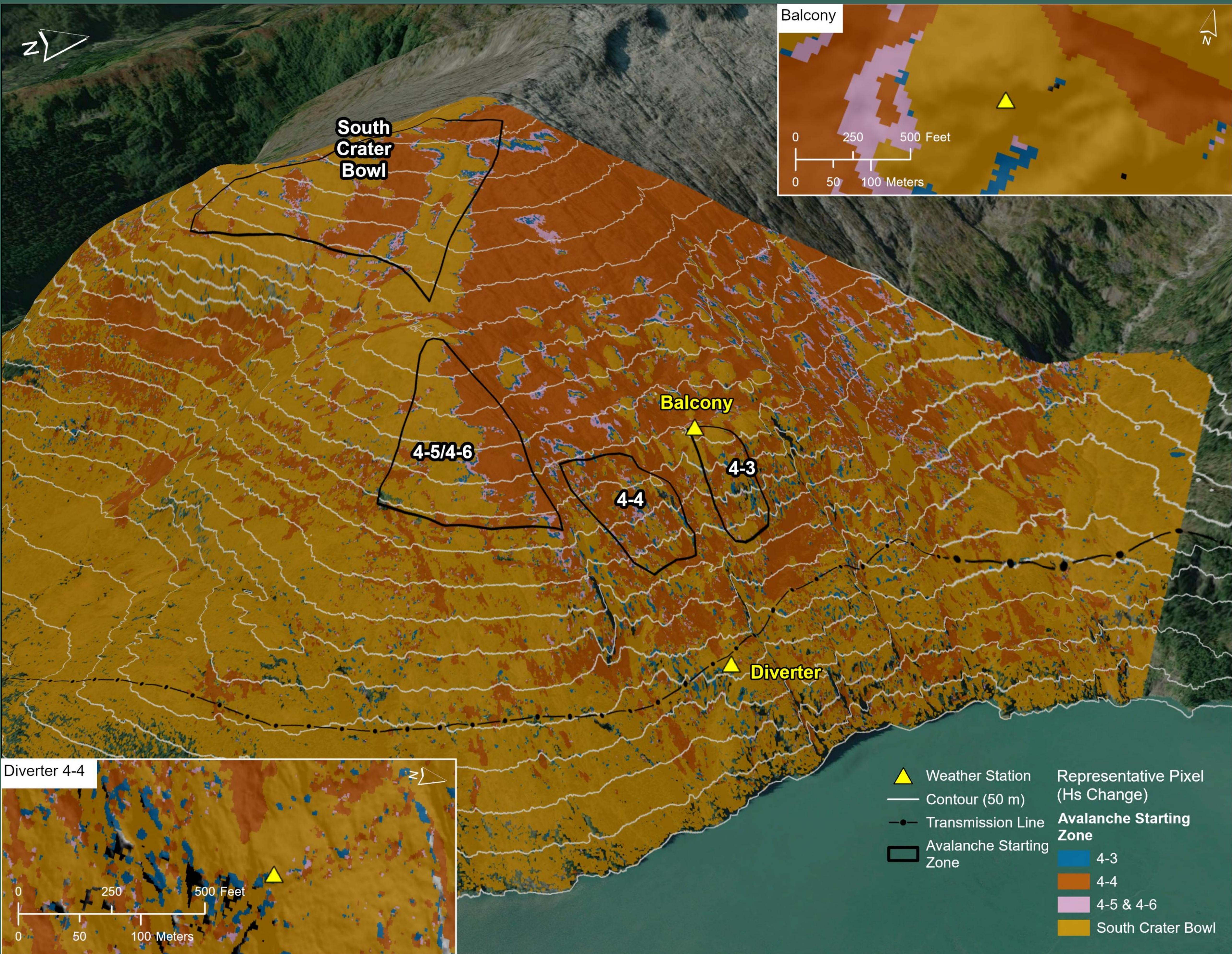


Figure 1: Snow depth *change* representativeness based on Euclidean distance similarity analysis. Raster pixels are colored based on which starting zone they are most similar. Analysis based on change in snow depth during February 2-March 13, 2020, and March 4-April 16, 2021.

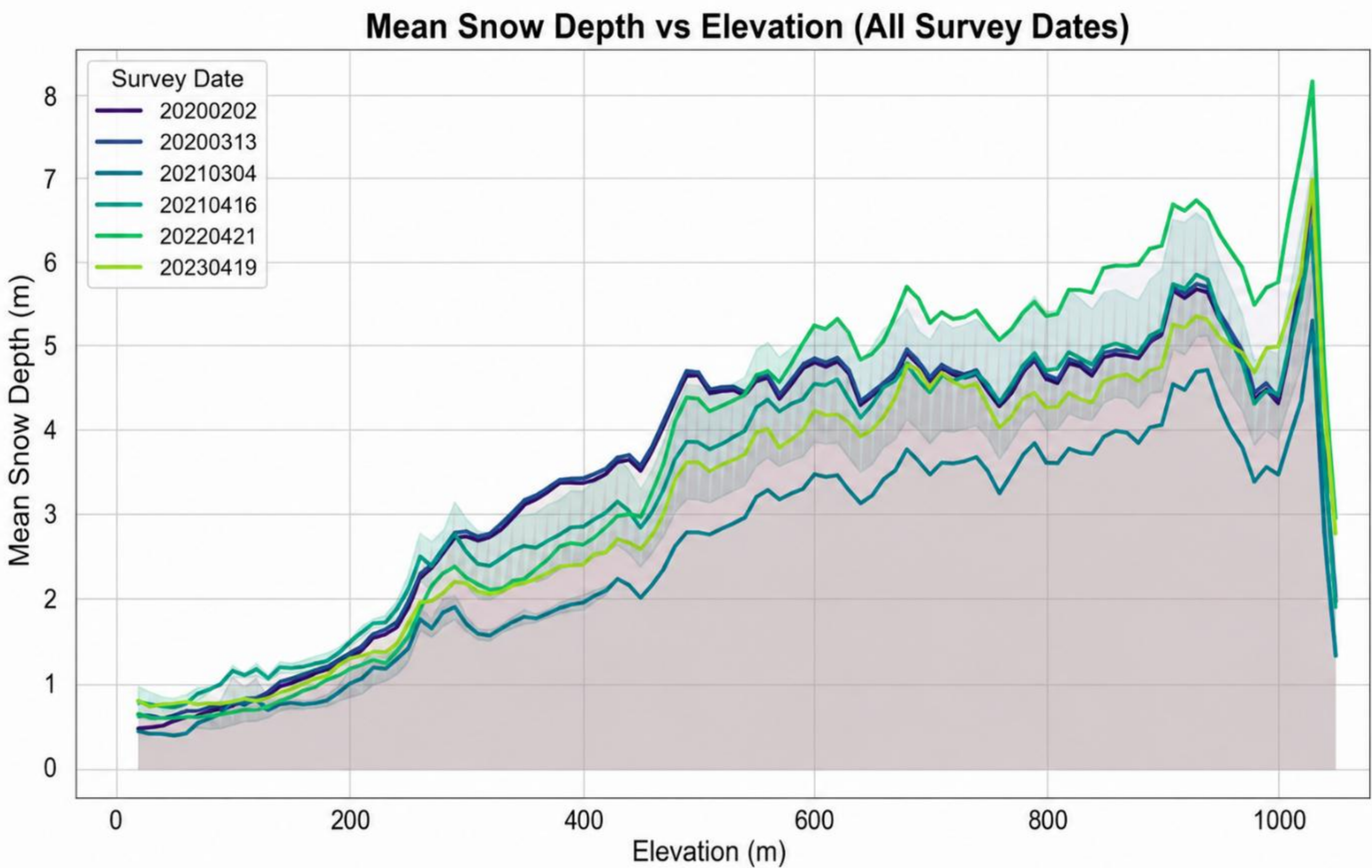
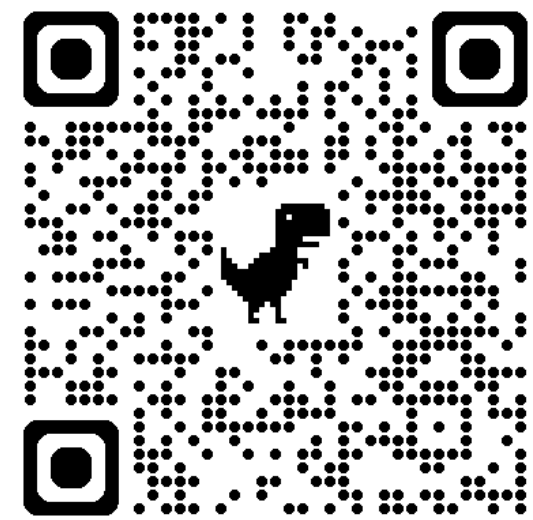


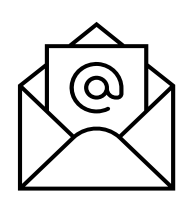
Figure 2: Elevational snow depth gradient for Speel Arm, southeast Alaska, based on all lidar acquisitions and snow depth averaged for 10 m elevation bins.

Access the full paper here



Lidar data reference
Wikstrom Jones, K.M., and Wolken, G.J., 2022: Lidar-derived elevation data for Speel Arm, Southeast Alaska, collected September 7, 2019: Alaska Division of Geological & Geophysical Surveys Raw Data File 2021-11, 8 p.
<https://doi.org/10.14509/30730>

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