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Remotely Measuring Snow Depth in Inaccessible Terrain

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In watershed-scale studies of snow accumulation, high alpine areas are typically important accumulation areas. While snow depth measurements may not be collected in these regions due to avalanche danger, failing to include them in basin-wide estimates of snow accumulation may lead to large underestimates of basin-scale water yield.
We present a new method to measure spatially distributed point snow depths remotely. Previously described methods using terrestrial laser scanning (TLS) systems, airborne light detection and ranging (LiDAR) systems, and hand-held laser distance meters have several limitations related to cost, data processing, and accuracy, thus reducing their applicability. The use of a modern robotic total station attempts to resolve these limitations. Total stations have much greater measurement accuracy than laser distance meters, and are significantly less expensive then TLS and LiDAR systems. Data can be output in common data formats, simplifying data processing and management. Measurement points can also be resampled repeatedly throughout the season with high accuracy and precision. Simple trigonometry is used to convert total station measurements into estimates of snow depth perpendicular to the slope.
We present results of remote snow depth measurements using a Leica Geosystems TCRP 1201+ robotic total station. Snow depth estimates from the station are validated against measured depths in a field trial. The method is then applied in a basin-scale study to collect and calculate high elevation snow depth, in combination with traditional snow surveys at lower elevations.

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