A Field Examination of Snowmelt Infiltration into Sloping Frozen Soils in the Canadian Rockies

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There is a very limited understanding of snowmelt infiltration into frozen soils on slopes. As a result, the application of existing infiltration estimation methods developed in level environments is uncertain for estimating spring runoff in mountain basins. A field study was conducted at the Canadian Rockies Hydrological Observatory using eight years of snowpack, liquid soil moisture and temperature profile observations from a north and south slope. To estimate spring infiltration, the antecedent liquid soil moisture at freeze-up, frost depth and any overwinter changes need to be estimated. Soils between the surface and 45 cm always froze over the winter, but frost depths varied from year to year. Freezing point depression curves showed evidence of a hysteretic relationship between liquid soil moisture and temperature. This relationship was used to estimate pre freeze-up soil moisture, which occurred at temperatures between -0.01 and -0.08 °C. The curves also indicate the occurrence of winter thawing and moisture redistribution in some years. Cessation of spring frozen soil infiltration was marked by a peak in liquid soil moisture before drainage occurred. Infiltration was estimated as the difference in soil moisture between the pre freeze-up and spring peak values. Estimated infiltration volumes were significantly lower and with less inter-annual variability than expected from Canadian Prairie studies, suggesting that existing infiltration estimation methods need modification. These differences are likely due to slope and textural and layering of soil types which affect gravitational, and tension processes. This analysis will assist in increasing the accuracy of infiltration measurements in mountain environments.