The Uncertainty of Snowmelt Basal Outflow using over 100 Snow Lysimeters

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Abstract. Snowmelt is an important part of the hydrologic cycle and ecosystem dynamics for headwater systems, though the physical process of water flow through snow is still a poorly understood aspect of snow hydrology. The shape of meltwater flowpaths tend to be highly complex. Flowpaths diverge and converge as percolating meltwater reaches a stratigraphic layer interfaces. In addition to spatial heterogeneity the snowpack will be temporally heterogeneous due to metamorphism that occurs during melt. This study uses the Soddie snowmelt lysimeter array designed to address the issue of spatial and temporal uncertainty of basal discharge at 105 locations over an area of 1300 m^2. In the Soddie lysimeter array, coefficients of variation ranged from zero to almost ten indicating more variability than previously observed, though this variability decreases with time and is explained by the flow of meltwater along snow layer interfaces. This results in snowmelt basal discharge significantly increasing as snow depth decreases. As the snowpack becomes less stratified through the melt season the pattern transforms from specific flowpaths to uniform matrix flow. The basal discharge correlation lengths correspond to a mean representative elementary area of 100 m^2, corresponding to a characteristic length of 10 m. As the complexity of terrain increases, the representative elementary area and uncertainty will increase. Snowmelt hydrologic models representing processes at scales less than these observed would need to explicitly incorporate the spatial variability of snowmelt discharge.