Antecedent moisture conditions and catchment morphology as controls on spatial patterns of runoff generation in small forest catchments

A.L. James (1) and N.T. Roulet (2)

(1) North Carolina State University, Raleigh, USA (april_james@ncsu.edu), (2) McGill University, Montreal, Canada (nigel.roulet@ncsu.edu)

Although existing empirical studies of runoff generation in headwater catchments have used stable isotopes to provide evidence of contributing sources of water to the stream channel in forest catchments around the world, spatially distributed datasets with which to test existing hillslope and watershed models remain limited. In this study, we examine the spatial patterns of storm runoff generation and in particular new-old water contributions, from eight small forest catchments (7-147 ha) located within the glaciated terrain of Mont Saint Hilaire, Quebec, Canada. Observations capture hydrologic response during 5 storm events of varying size delivered on strongly different moisture conditions. With the transition from wet to dry conditions, local groundwater stores become depleted in several ephemeral catchments and new water, delivered by shallow subsurface stormflow and the transient development of perched water in valley-bottoms can account for much larger percentages of total runoff (up to 76% of total runoff). During dry conditions, distinct scaling of new water delivery attributable to basin morphology was observed. A number of storms on wet conditions exhibit no consistent pattern with strong variability of new water delivery among the smaller catchments. The results presented here illustrate the complexity of influences of antecedent moisture conditions, storm conditions and catchment morphology on spatial patterns of runoff generation in headwater systems.