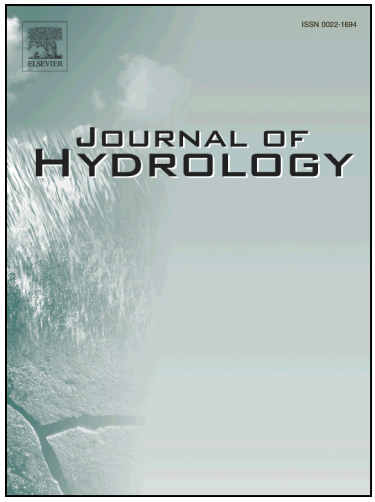

Research papers

Fill and spill drives runoff connectivity over frozen ground

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Fill and spill drives runoff connectivity over frozen ground

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Abstract

Snowmelt-runoff processes on frozen ground are poorly understood at the hillslope scale. This is especially true for hillslopes on the northern Great Plains of North America where long periods of snow-covered frozen ground with very shallow slopes mask any spatial patterns and process controls on connectivity and hillslope runoff generation. This study examines a 4.66 ha (46,600 m^2) hillslope on the northern Great Plains during the 2014 spring snowmelt season to explore hillslope runoff processes. Specifically, we explore the spatial patterns of runoff production source areas and examine how surface topography and patterns of snow cover, snow water equivalent, soil water content, and thawed layer depth – which we measured on a 10 m grid across our 46,600 m^2 hillslope – affect melt water partitioning and runoff connectivity. A key question was whether or not the controls on connectivity are consistent with the fill and spill mechanism found in rain-dominated and unfrozen soil domains. The contrast between the slow infiltration rates into frozen soil and the relatively fast rates of snowmelt delivery to the soil surface resulted in water accumulation in small depressions under the snowpack. Consequently, infiltration was minimal over the 12 day melt period. Instead, nested filling of micro- and meso-