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Hydrological flow paths during snowmelt: Congruence between hydrometric measurements and oxygen18 meltwater, soil water and runoff

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Streamflow generation in boreal catchments remains poorly understood. This is especially true for snowmelt episodes, which are the dominant hydrological event in many seasonally snow covered regions. We examined the spatial and temporal aspects of flowpaths by linking detailed oxygen 18 observations of stream, melt, soil and groundwater with hydrometric measurements in a small catchment in northern Sweden during snowmelt period. The results demonstrate that soil horizons below 90cm were hardly affected by the approximately 200m of snowmelt water infiltrating into the soil during spring. The approximately sixty-fold increase in runoff, from 0.13mm d-1 to 8mm d-1, was generated by a 30-40cm rise of the groundwater level. The total runoff during the snowmelt period from late April to late May was 134mm, of which 75% was prevent water. Mass balance calculations based on hydrometric and isotopic data independently, both using upscaling of a hillslope transect to the entire 13ha catchment, provided similar results of both water storage changes and the amount of event water that was left in the catchment after the snowmelt. In general, groundwater levels and runoff were strongly correlated, but different functional relationships were observed for frozen and unfrozen soil conditions. Although runoff generation in the catchment generally could be explained by the transmissivity feedback concept, the results suggest that there is a temporal variabilities in the flow pathways during the spring controlled by soil frost during early snowmelt.

References: Laudon, H., Seibert, J., Köhler, S.J. and Bishop, K., 2004. Hydrological flow paths during snowmelt: Congruence between hydrometric measurements and oxygen18 meltwater, soil water and runoff. Water Res. Res. 40, WO3102.