Diurnal changes in isotopic and chemical content of a headwater stream during snowmelt runoff.

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Abstract. Solutes are discharged from seasonal snowpacks in the form of an ionic pulse, where approximately 80% of the solute load is released in the first 20% of snowmelt. An outstanding question is how the quality of surface waters responds to this ionic pulse. We collected surface waters for chemical and isotopic analysis every 4 hours during the first 30 days of snowmelt runoff from the 8-ha Martinelli catchment, Colorado Front Range. During a one week period at the onset of snowmelt, concentrations of base cations (Ca^{2+}, Mg^{2+}) and acid anions (NO_3^-, SO_4^-, Cl^-) peaked at noon each day and followed a diurnal signal. Ca^{2+} varied diurnally by an average factor of 1.7 over twenty-hour intervals (ex. 58.4 μeq/L < Ca^{2+} < 103.0 μeq /L). Mg^{2+} followed a similar pattern fluctuating between 10.9 and 17.9 μq /L in the same time frame. Anions of strong acids displayed the most significant and rapid diurnal variations with nitrate increasing by a factor of 4.0 over a twenty-hour period at the onset of melt (14.5 μeq /L < NO_3^- < 57.1 μeq /L). $\delta^{18}O$ values also demonstrated a diurnal pattern, exhibiting minimum values at noon with differences of almost 2‰ through diurnal cycles. Maximum daily discharges and minimum daily solute values occurred in the next four-hour interval, along with the most enriched $\delta^{18}O$ values during this afternoon period. These results suggest that the release of solutes from the snowpack in an ionic pulse caused concentrations of base cations and anions to increase daily by a factor of 1.5 to 4.0. This inverse relationship between discharge and solute concentration was lost following the first week of snowmelt as flows rapidly increased on the rising limb of the hydrograph.