A thirst for snowmelt? Tree water use in spring

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Describing the water sources for tree transpiration and how sources vary in time and space is fundamental to understand how vegetation impacts the hydrological cycle. While many tree water source partitioning studies have focused on the growing season, little is known about transpiration sources before, during, and after snowmelt when trees rehydrate and recommence to transpire in spring. Here we investigate spring snowmelt and the onset of tree rehydration and transpiration in two sites within the boreal forest of Saskatchewan, Canada. Specifically, we investigate the source of transpiration during the first days and weeks after transpiration onset relative to snowmelt timing. We document the source of transpiration of three boreal forest tree species—jack pine (Pinus banksiana), black spruce (Picea mariana), and larch (Larix laricina)—by combining observations of weekly stable isotope values of xylem, soil water, rainfall, and snowmelt with physical measurements of soil moisture dynamics, snow depth and high-temporal resolution measurements of tree stem radius and sap flow. We show that the onset of rehydration and transpiration overlaps snowmelt and that trees use snowmelt water during stem rehydration and the onset of transpiration. Soil water showed a rapid shift to isotopically depleted-snowmelt water values during the end of the snowmelt period. But our data showed a delay in the shift in xylem isotope signatures from pre-melt to the clear snowmelt-depleted water signatures that dominate thereafter. This appears to be controlled by tree water transit time that was in the order of 9 to 18 days. Our study shows that snowmelt is an important source for stem rehydration and the onset of transpiration in the boreal forest during spring onset. Our data also highlights the importance of monitoring phenological and physiological responses during tree water source investigations. In a warmer world, the timing of snowmelt and vegetation phenology are likely to continue to change, as well as the decline in water availability via snowmelt in northern ecosystems. Therefore, understanding tree water use dynamics during spring onset is important to identify the impact of climate change on the evolution of forest composition and groundwater
recharge.