



Climate warming causes intensification of the hydrological cycle resulting in changes to the vernal and autumnal windows in a northern temperate forest

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Climate warming is likely to lead to complex effects on northern forests of the temperate forest biome. We investigated whether rising temperatures altered the timing of snowmelt and snowpack accumulation or extended the forest growing season length in the Turkey Lakes Watershed in Central Ontario. Archived satellite imagery was used to track changes in timing of snow pack loss/gain and canopy leaf on/off; the periods between these events were defined as the vernal (spring) and autumnal (fall) windows. We found only a slight extension of the growing season into the autumn period and no increase in the width of the vernal or autumnal windows, indicating that forest growth is not responding significantly to temperature increases during these windows. Archived time series of temperature, precipitation and discharge data for a nested set of catchments ranging in size from headwater (<10 ha) to regional (103 ha) catchments were used to track changes in the magnitude, timing and partitioning of precipitation into evapotranspiration and discharge. We found an intensification of hydrological cycling, with (1) a higher dryness index (PET/P) during the summer growing season, and (2) earlier spring snowmelt discharges and later more concentrated autumn storm discharges during the shoulder seasons. This intensification of the hydrological cycle during the summer growth season and the vernal and autumnal windows may not only limit opportunities for enhanced forest growth, but may be contributing to the recent observations of forest decline within this biome.