Snowmelt infiltration through partially frozen soil in Finnish Lapland

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Snowmelt timing is critical for tree growth in high latitudes. However, the threshold conditions with respect to root-zone soil water availability in spring are not well understood. We measured snowpack thickness, apparent snow water (ASW), air and soil temperature, as well as soil water content (SWC) in Moskuvaara (67˚37’34’’N, 27˚10’30’’E) and Järvijoki (68˚02’17’’N, 26˚05’49’’E) sites in spring 2008. The sites host mature Norway spruce stands underlain by Haplic Podzol developed on silty and sandy tills. Soil temperature probes (T107) and soil water content reflectometers (CS616) were placed at 20-cm-increments into the soil sequence. Snow depth was measured with (SR50A) sonic range sensors (Campbell; see photo below) and ASW with dielectric leaf wetness sensors (Decagon). All parameters were automatically logged with Campbell CR1000 data-logger in 3-h-intervals. The maximum snowpack thickness varied from 84 cm (on 30th of March) in Moskuvaara to 90 cm (on 14th of April) in Järvijoki. Due to air temperature rise notably above zero 0˚C on mid-April, the onset of snowmelt occurred on 29th of April 2008 at both sites. The observed maximum ASW was simultaneous with the maximum SWC on the 2nd of May (see graph below). At 60 cm depth soil remained unfrozen through winter. In contrast, soil temperature at 20-cm-depth was below zero 0˚C until 18th of May in Moskuvaara and 28th of May in Järvijoki. These dates were rather concurrent with snow disappearance; 15th of May in Moskuvaara and 25th of May in Järvijoki. Snowmelt water percolated through the soil such that SWC (at 20-cm-depth) had its maximum 16 days (Moskuvaara site) and 26 days (Järvijoki site) before the soil temperature exceeded 0˚C.

We contend that snowmelt infiltration through partially frozen soil significantly contributes to ground water reserves and soil water availability, rather than soil temperature, is pivotal for the start of height increment of trees in northern boreal conditions.

References
