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Effects of snow cover change on taiga forest ecosystem

Global air temperatures continue to rise and an effect of global warming is stronger in the North. The air temperature already increased for 2-3 degrees in Siberia (Serreze and Barry, 2011) and will continue to rise in the future (IPCC 5th report). Increasing air temperatures and winter precipitation may affect vegetation through change in snow cover onset and its depth because these snow parameters possibly affect soil moisture and soil temperature, alter nutrient availability in the following growing season (Walker at al. 1995; Decker et al 2003; Natali et al 2012)

To understand effects of changing snow cover depth on taiga forest ecosystem, snow manipulation experiment was conducted in winter of 2015 in taiga forest dominated by *Larix cajanderi* at Spasskaya Pad experimental forest (the Republic of Sakha, Russia). Snow from 20 x 20 m plot was transported to another plot with the same area and spread out evenly.

In the following growing season small larch trees needle elongation and thaw layer depth was manually measured, and to know initial conditions and estimate the effect of snow manipulation, soil and larch stem were sampled before and after the experiment. Shoot and needle samples were collected only after manipulation. Further water from soil and stem was extracted cryogenically and analyzed for water isotope composition. In addition, needle and shoot carbon and nitrogen content as well as their isotopic ratios were analyzed.

Effects of snow cover depend on vegetation cover and region specific (Juan et al 2014). Boreal and temperate forests with thin organic layer are more susceptible to freezing disruption (Hardy et al 2001). Our results show that after snow manipulation, soil temperature decreased significantly at Snow- plot for soil layers from surface to 80 cm. In spring, advanced snowmelt of reduced snowpack increased summer soil temperature, but decreased soil moisture. Changes affected phenology of larch trees by slowing the speed of needle elongation and decreased nutrient availability in soil and thus decreased nitrogen content in needles in July, although did not affect needle length and nitrogen content in August. We suggest this may be results of reduced nitrogen availability in soil and inability of plant to uptake soil nitrogen due to lowered soil moisture or frost-induced fine-root damage caused by increased frequency of freeze-thaw cycles during snow-free period.

At Snow+ plot, small trees needles at Snow+ plot were significantly longer during early growing season, but at the end of summer the difference in needle length was not significant. Increased nitrogen content of soil and mirroring increase of needle nitrogen content suggest higher nutrient availability and increased uptake of these nutrients with 20% higher soil moisture at Snow+ plot and insulating properties of increased snowpack reduced frequency of freeze-thaw cycles

Higher nitrogen content of needles at Snow+ and larger soil ammonium pool in July may be a result of higher winter soil temperature due to increased insulation by snow cover which led to higher microbial activity (Schimel et al 2004). Lower needle nitrogen content and soil ammonium at Snow- was observed because soil decomposer communities were disturbed by extreme soil frost in winter or freeze thaw cycles in spring (Sulkava et al 2002). Therefore, manipulated snow cover during winter had the effect on larch tree phenology through soil moisture and soil nutrient availability during summer. Expected increase in production (Bosio et al 2014) will be studied in further research.