2015 ESS PI Meeting
Student Abstract

Increased Nitrogen availability in a tundra ecosystem during five years of permafrost thaw

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The globally significant size of the permafrost carbon (C) pool reflects the balance between soil decomposition and plant growth in high latitude ecosystems. Projected increases in mean annual temperatures in these cold ecosystems are expected to increase rates of both C uptake and release. The Carbon in Permafrost Experimental Heating Research (CiPEHR) is a manipulative warming experiment started in the winter of 2008 to enhance our understanding of tundra ecosystems experiencing permafrost thaw. Soil warming at CiPEHR is applied in the winter using snow fences that increase insulation against cold winter air temperatures. Higher soil temperatures translate to deeper thaw during growing season; as a result the active layer thickness in soil warmed plots has progressively increased every year of the experiment (2.8 cm deeper than control in 2009, 11.5 cm deeper than control in 2013). An air warming treatment is applied during the growing season using open top chambers that warm the air above plots an average of 0.4°C. My dissertation research focuses on changes in N cycling between plants and soils during the process of permafrost thaw. Nitrogen (N) is expected to play a key role in determining the future balance of soil C losses and increased C sequestration by plants because it is the main nutrient limiting plant productivity and soil organic matter decomposition in high latitude ecosystems. Within the context of the CiPEHR experiment, my research has been comprised of plant surveys, foliar sample collection, continuous environmental monitoring and analysis of ion binding resin bags that measure the availability of inorganic N forms in surface soils. I have also performed off-plot harvests that improve upon existing site and species specific allometric relationships that allow aboveground biomass to be calculated with greater accuracy. Results from this research show a significant increase in aboveground plant biomass with five years of soil warming ($p<0.05$) that is primarily driven by the growth of the dominant tussock forming sedge, *Eriophorum vaginatum*. Analysis of *Eriophorum* foliar samples collected at peak growing season show no significant change in the %N during any of the five years of warming. Resin bags deployed at 10cm depth in the soil profile for the 2012 and 2013 growing seasons demonstrate a significant increase in available inorganic N associated with soil warming ($p<0.05$) as well a significant increase with air warming ($p<0.05$). Interestingly, resin data also show a significant negative interaction between the two treatments ($p<0.01$). Together, these results suggest that 1) Plant access to N has increased with permafrost thaw in the soil warming treatments and 2) Combined air and soil warming treatments limit N cycling and potentially productivity. Isotopic analysis of *Eriophorum* foliar samples showed no effect of warming treatments on the foliar $\delta^{13}C$ signature, signifying water stress does not explain the diminished response in combined treatment plots. The foliar $\delta^{15}N$ signature of *Eriophorum*, however, does decrease with soil warming throughout the course of the five year experiment ($p<0.05$). This indicates that the soil source or microbial pathway through which *Eriophorum* is acquiring N is changing as the thaw depth progresses downwards. Such a dramatic change in the N cycle bodes well for plant productivity under warmer conditions but this shift has the potential to remove the current N limitation of the microbial community in surface soils, further reducing the C storage capacity of these thawing soil profiles.