

SPRUCE Deep Peatland Heating: System Performance and Measured “Ecosystem” Net Surface CO₂ and CH₄ Responses

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Deep soil heating infrastructure was completed in 2014 for a peatland whole-ecosystem warming study that will include air warming starting in 2015 (SPRUCE; <http://mnspruce.ornl.gov>). In June 2014, deep soil heating was initiated to test the responsiveness of deep peat carbon stocks, microbial communities and biogeochemical cycling processes to heating at 4 warming levels (+2.25, +4.5, +6.75 and +9 °C; 2 replicate plots) compared to fully-constructed control plots (+0 °C; 2 replicate plots). The warming treatments were deployed over eight 113 m² areas using circular arrays of low-wattage (W) electrical resistance heaters. With an average peat depth of 2.5 meters this system was able to warm approximately 113 of the 282 m³ of peat within each target plot. In the absence of the air warming cap, *in situ* deep peat heating is only effective at sustaining warming in the deep peat layers. Warming levels at depth were achieved over a 25-day (+ 2.25 °C) to a 60-day (+9 °C) period depending on the target treatment temperatures in agreement with a priori energy balance model simulations. Initial biological and biogeochemical responses to these manipulations are being actively assessed. The mild and gradual warming treatments took several months to produce enhanced levels of net CH₄ flux for the treatment plots proportionate to measured levels of deep peat warming. The enhanced levels were only maintained during the warm growing season, and dropped to near zero when surface conditions were frozen. Other data suggest that CH₄ generation within the peat column may be limited to current photosynthate supplies that become limited in the cold portion of the year. Limited surface aerobic zones did not produced enhanced net dark CO₂ fluxes from the plots, but this pattern is expected to change with whole-ecosystem warming in 2015. Late winter and pre-thaw assessments of belowground CO₂ and CH₄ production are scheduled for April 2015. They are expected to provide insights into deep peat responses to sustained and historically unprecedented warming.