Impacts of Elevated CO₂ and Whole Ecosystem Warming on Photosynthesis and Respiration of Two Ericaceous Shrubs in a Northern Peatland

Eric J Ward¹*, Jeffrey M Warren¹, Stan D Wullschleger¹, Anthony W King¹, Daniel M Riccuito¹ and Paul J Hanson¹

¹Environmental Sciences Division and Climate Change Science Institute, Oak Ridge National Laboratory, Oak Ridge, TN

Contact: wardej@ornl.gov

BER Program: TES
Project: ORNL Terrestrial Ecosystem Science SFA
Project Website: http://mnspruce.ornl.gov/

The Spruce and Peatland Responses Under Changing Environments (SPRUCE) project is a large-scale, long-term experiment investigating the effects of warming and elevated CO₂ on an ombrotrophic bog in Minnesota. Globally, such northern peatlands store an estimated 500 ± 100 Pg C, a disproportionately large amount relative to the land area they cover. SPRUCE is utilizing 10 large (12-m diameter) enclosures to increase air and soil temperatures to a range of targets (+0 °C, +2.25 °C, +4.5 °C, +6.75 °C, +9 °C) under both ambient and elevated (+500 ppm) CO₂ concentrations for 10 years. This poster focuses on the responses of the two dominant ericaceous shrubs (Rhododendron groenlandicum and Chamaedaphne calyculata), quantifying the seasonal patterns of photosynthesis and respiration to the first two years of temperature and CO₂ treatments. These two species dominate the understory at this site (~80% of biomass) and are 35% more productive than the trees in this open canopy forest. Whole ecosystem warming extended the physiologically-active season in both spring and fall for these years, increasing the period of active carbon assimilation. Gas-exchange results from the first year exhibited some photosynthetic acclimation to CO₂ treatments and respiratory acclimation to temperature, although the degree of acclimation was species-specific in each case. Nitrogen per unit leaf mass of R. groenlandicum decreased under elevated CO₂, but nitrogen per unit leaf area was maintained by a concurrent increase in leaf mass per area. Detailed gas exchange measurements from the second growing season revealed the trade-off between photosynthetic and respiratory rates that underpin a broad thermal optimum of net assimilation rates. We illustrate how these results will be incorporated into modeling efforts for northern peatlands in global dynamic vegetation models.