Project Abstract

Measurement and Modeling Component and Whole-System CO_2 flux at Local to Regional Scales in Northern Wisconsin

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This project, moving into its third year, is a collaborative project led by Paul Bolstad of the University of Minnesota. This abstract summarizes the overall project, while highlighting the contributions from Penn State. The enclosed budget includes only Penn State's portion of the project for the final year. The enclosed full statement of work encompasses the entire project.

Our overall goal is to understand the carbon cycling of wetlands, an important component of a complex northern forest biome. The work quantifies landscape-scale variability in soil surface respiration, particularly in wetlands and at wetland margins, and a small set of upland types, and combines these with data collected previously on uplands to enhance a mosaic of regional contributions to carbon fluxes obtained via this and previous studies. We also analyze high-quality, continuous measurements of canopy net ecosystem-atmosphere exchange (NEE) of CO_2 in a shrub wetland. These wetlands, while located in the northern portion of the temperate zone, share many characteristics with a circumpolar wetland zone. Wetlands in the upper Lake States are at the southern edge of this zone, and thus are vulnerable to climate change.

The Lost Creek research is synergistic with a set of past and ongoing studies in the region. Past work has quantified component and whole-system carbon pools and fluxes for several major upland stand-types, as well as leaf area index (LAI) and above-ground net primary productivity (ANPP) of both upland and wetland stand types. This work is in the footprint of the globally-unique WLEF tall tower, which provides a high-quality, landscape-scale measurements of ecosystem-atmospheric carbon exchange, and near two other stand-level towers representative of mature and old-growth upland forests. This regional network will enable a unique set of intercomparisons with the Lost Creek measurements. The combined research will provide one of the most complete regional understandings yet assembled of landscape respiration and NEE.

Towards these ends, Penn State staff will continue to provide detailed analysis of the high quality, continuous, whole system measurement of NEE via eddy covariance at the Lost Creek flux tower. Lost Creek is the only wetland flux tower in the Midwest, one of few wetlands towers in the Ameriflux network, and the only wetland flux tower near the temperate/boreal margin. Environmental and component flux measurements at the Lost Creek will be analyzed to identify the primary drivers of intra and interannual variation in NEE of CO_2. We will identify the relative importance of air temperature, soil temperature, PAR, and water table height on total ecosystem carbon balance, and the underlying changes in component soil and plant fluxes at the Lost Creek site. This understanding of the dependence of Lost Creek fluxes on environmental variables will provide guidance for the development of models of wetland carbon and water cycling. The site, for example, shows a consistent, weak sink of carbon in the Lost Creek shrublands, despite a relatively strong drying trend over past years which we hypothesized might be causing large respiratory fluxes at wetland margins. Our final year of research will allow us to add results of the very dry year of 2005 to this study.

Further, the degree to which interannual variability in carbon and water fluxes is consistent among Lost Creek and other flux towers in the region will help us to elucidate the causes of interannual variability in regional-scale NEE, and to evaluate the degree of complexity required by ecosystem models to properly simulate ecosystem-atmosphere fluxes in this complex forest biome. Measurements at Lost Creek have, to date, shown little interannual variability when compared to the upland forest sites and the WLEF tall tower, suggesting that the carbon cycle of the wetland component of the regional ecosystem is relatively insensitive to climate variability on short time scales.