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ABSTRACT TITLE: Resolving scale-dependencies in the effects of canopy structure on carbon, water, and energy fluxes in a mixed deciduous forest.

ABSTRACT: The future of the North American carbon stocks and fluxes remains uncertain as mixed deciduous forest of the Midwest and East U.S. transition from early to middle and late successional stages. As the succession happens, the canopy structural and functional attributes change which affect a multitude of phenomena, ranging from canopy light, water and nutrient usage to turbulent mixing of air within the canopy. By taking advantage of the Forest Accelerated Succession ExperimenT (FASET), in which aspen and birch were girdled in an area of 39 ha, we intend to improve the current understanding of how carbon and water vapor fluxes respond to changes in the canopy structure as the vegetation recovers from the imposed disturbance.

Our ongoing study is a multi-front approach, where computer models operating in a wide range of scales (from individual trees to regions) aid the interpretation of empirical measurements of the response of water, carbon, and energy fluxes to the imposed structure/function changes. These include OLAM – a new global-regional model with extreme zoom-in capabilities, RAFLES – a high-resolution canopy resolving large eddy simulation and tRIBS+VEGGIE – a high resolution vegetation resolving hydrological model. We find strong scale dependencies for the effects of structural changes, and that physiological processes, such as tree-level hydrodynamics and nutrient cycling, are critical to the prediction of stomata conductance and carbon dynamics. Our models were able to predict some of the outcomes of structural changes to NEE and forest carbon storage by resolving these functional processes at very high resolutions. Our results can reduce the uncertainty of forecasts of terrestrial carbon storage and advance the formulation of forest management guidelines for enhancing carbon sequestration in older forests and in forests experiencing moderate disturbance.