From Below- to Aboveground, and Integrated Ecosystem Drought Responses

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Drought, a pervasive threat to plant productivity across the globe, is projected to intensify under climate change. Accurate representations of plant and ecosystem drought responses are needed for carbon cycle/climate projections to support decision making for adaptation and risk management. While many aspects of plant drought responses are well-understood, there are gaps in mechanisms, methodologies, and data at the scale of whole ecosystems. Specifically, how the dynamics of processes throughout the entirety of the soil-plant-atmosphere continuum aggregate to control ecosystem-level responses and feedbacks to drought of varying intensities and frequencies. To address these gaps, we leverage the unique data sets collected at the Missouri Ozark AmeriFlux (MOFLUX) site, which is situated in a drought-prone *Quercus-Carya* (oak-hickory) forest in the transitional zone between the Eastern Deciduous Forest and the Great Plains. This site experiences frequent seasonal physiological drought, and a broad range of conditions ranging from years with no water stress to exceptional drought. MOFLUX is thus an ideal testbed for observing and modeling drought responses at a range of spatiotemporal scales, and our historical monitoring has emphasized the coordinated collection of ecosystem flux, soil, and ecophysiological data.

Our recent efforts have focused on developing understanding of the coupling of above- and below-ground processes to shed light on how forests respond to drought. Specifically, this has involved the addition of capacity for partitioning soil respiration into heterotrophic and autotrophic component fluxes, the observation of canopy sun-induced chlorophyll fluorescence (SIF) as a direct signal of photosynthesis and augmented measurements of leaf water potentials. Our overall scientific approach has focused on three areas: (i) studying the drought response of soil respiration and its components, (ii) how drought affects the coupling of photosynthesis with soil respiration fluxes, and (iii) developing the theory and testing ecosystem-level drought response traits that can be derived from flux and leaf water potential observations (e.g., a whole-ecosystem wilting point).

This “Spark” talk will provide an overview of these research activities and perspectives on how these empirical analyses can address deficiencies in modeling ecosystem drought responses. Specifically, we will emphasize what we see as the value of ecosystem functional traits for understanding drought responses and how they can be used to better evaluate the performance of models.