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Developing a Continental-scale Theory for Predicting Ecosystem Transpiration with NEON Flux Tower Measurements

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The water and carbon cycles are fundamentally coupled through transpiration and photosynthesis, as plants inevitably lose water in order to gain carbon. However, isolating transpiration from the "bulk" terrestrial water-flux of evapotranspiration has remained challenging and difficult to scale. Several methods have been proposed to estimate transpiration and canopy conductance, which reflects the canopy-scale regulation of transpiration, but they have generally been applied narrowly or non-systematically. The U.S.-based National Ecological Observatory Network, however, is entering operation and is poised to provide eddy covariance and isotopic measurements of carbon dioxide and water vapor in a consistent manner at a continental scale. When combined, isotopic measurements of carbon dioxide and water vapor and eddy covariance measurements allow for the development of semi-independent, robust, and standardized estimates of ecosystem transpiration and canopy conductance. Here, we provide initial estimates of isotope ratios of carbon and water fluxes and their variability across 20 sites that have available paired isotopic and eddy covariance measurements. Follow-on field work over the next two years will add additional constraints on ecosystem traits and soil water isotope ratios to help refine estimates of transpiration fluxes and relate spatial and temporal variability in transpiration and canopy conductance to plant functional traits. Finally, our estimates of transpiration, its spatiotemporal variability, and its covariance with plant traits will be used to improve representation of transpiration processes in ecological and land-surface models. Refinements to our understanding of continental-scale controls and variation in transpiration gleaned from this project will better inform our projections of ecosystem response and resilience to future environmental conditions.