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Estimation of tree water relationships using a Soil-Tree-Atmosphere Continuum model

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To better understand root-soil water interactions, a mature white fir (Abies concolor) and the surrounding root zone were continuously monitored (sap flow, canopy stem water potential, soil moisture, and temperature), to characterize tree hydrodynamics. We present a hydrodynamic flow model, simulating unsaturated flow in the soil and tree with stress functions controlling spatially distributed root water uptake and canopy transpiration. Using the van Genuchten functions, we parameterize the effective retention and unsaturated hydraulic conductivity functions of the tree sapwood and soil, soil and canopy stress functions, and radial root zone distribution. To parameterize the in-situ tree water relationships, we combine a numerical model with observational data in an optimization framework, minimizing residuals between simulated and measured observational data of soil and tree canopy. Using the MCMC method, the HYDRUS model is run in an iterative process that adjusts parameters until residuals are minimized. Using these optimized parameters, the HYDRUS model simulates diurnal tree water potential and sap flow as a function of tree height, in addition to spatially distributed changes in soil water storage and soil water potential.