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Bayesian Calibration of a Soil-Root-Plant-Atmosphere Continuum Model Using Soil Moisture and Leaf Water Potential Data

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The current need to better understand plant health in water-limited ecosystems justifies the increasing need for combining soil knowledge with plant expertise, in particular as related to root development and functioning. We will present a numerical modeling approach that simulates the soil-root-plant-atmosphere continuum as a single integrated numerical system, using the HYDRUS model. In this approach, we approximate both the soil and plant conducting tissues by a porous medium, each with conductive and capacitive properties that are a function of water potential. Our modeling system is especially designed to directly link the atmosphere to soil moisture uptake and stress.

The model will be tested using data collected for a single white fir tree (CZO-TREE 1) at the Kings River Experimental Watershed, as part of the Critical Zone Observatory (CZO) project in the Southern Sierra mountains in California. Data include soil water content and water potential in 3 spatial dimensions in the root zone, tree stem water content and sap flux, canopy water potential, and atmospheric variables such as net radiation, air temperature and humidity. Our initial results show that our Bayesian calibration of soil, xylem, and root system properties results in fairly accurate simulations of measured soil moisture dynamics. Moreover, our calibrated HYDRUS model predicts independently measured sapflow data quite well.