

Tree specific traits vs. stand level characteristics - assessing the source depths of plant water uptake in a mixed forest stand

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Due to differences in fine root distributions, physiological root characteristics and plant plasticity, the spatial and temporal characteristics of plant water uptake are expected to vary between different tree species. This has implications on the overall water budget of a forest stand as well as on the drought sensitivity of particular trees. A four-year time series of climate data, soil moisture, and stable water isotopes in soil and tree xylem was used to investigate plant water uptake dynamics of four tree species (beech - *Fagus sylvatica*, spruce - *Picea abies*, ash - *Fraxinus excelsior* and maple - *Acer pseudoplatanus*) in a mixed forest stand. Modeling with a modified version of the soil hydrological model Hydrus-1D allowed us to simulate continuous time series of stable water isotopes in plant water uptake, which were compared to the measured values in tree xylem water and soil water.

We found that different estimated species specific fine root distributions and root water uptake parameters lead to very similar simulated water balances and soil water isotope depth profiles for all four species. According to our simulations, differences in evaporative demand (i.e. LAI) had the biggest influence on water uptake and soil water distributions. Comparing the isotopic signatures of simulated root water uptake and measured xylem water, the simulations for beech were most suited to predict the observed signatures of all four species. This indicates that isolated, tree specific parametrized 1-D simulations are not suited to predict actual water uptake of different trees in a mixed stand. Due to overlapping root spaces dominant trees (in our case beeches with an LAI of around 5.5) may influence the soil water storage below accompanying trees (spruces, ashes and maples with LAIs between 1.8 and 3.1) in a degree that their actual water uptake cannot be predicted with 1-D simulations based on their smaller LAI values. Consequently, for a mixed forest stand the interplay of trees with different traits has to be accounted for in order to correctly model plant water uptake of single trees.