Using stable water isotopes to trace the sources of plant water uptake

Stefan Seeger

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Introduction

In most terrestrial ecosystems the water use of vegetation is a key control on the water balance. Consequently, a wider knowledge of the processes involved in plant water uptake (PWU) is beneficial for designing suitable ecological, hydrological and climatic models, which may be able to provide useful insights into future conditions under the influence of changing land use and climate.

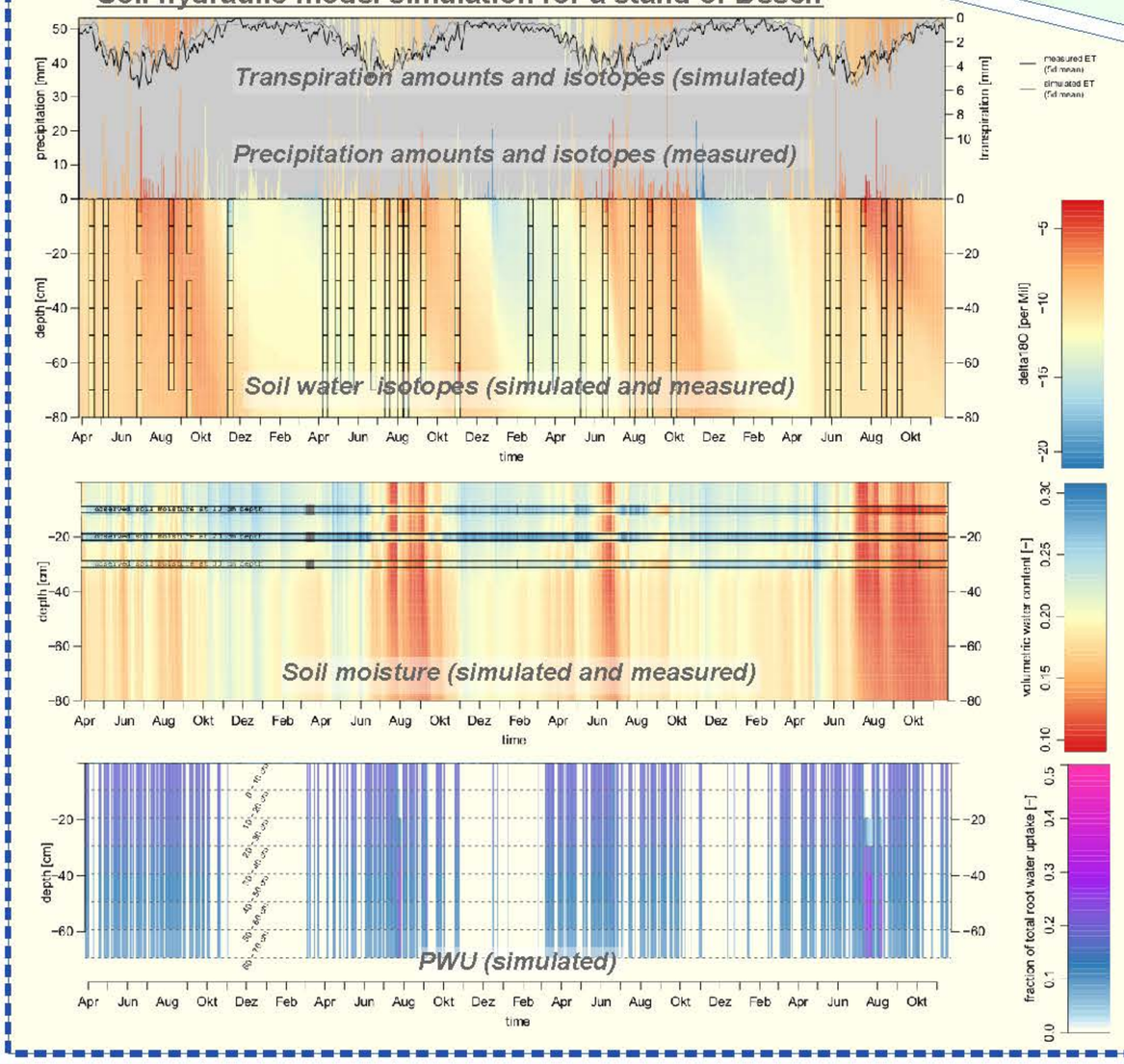
As PWU usually takes place beneath the soil surface, its observation proves to be rather tedious. Therefore, the current knowledge about PWU is sparse and limited to a small set of plant species.

Objectives

- **Development of an efficient measurement procedure to identify the source depths of PWU**
- **Measurement of PWU source depth patterns for a variety of vegetation types under normal and drought conditions**
- **Comparison of the observations with simulations of widely used models**

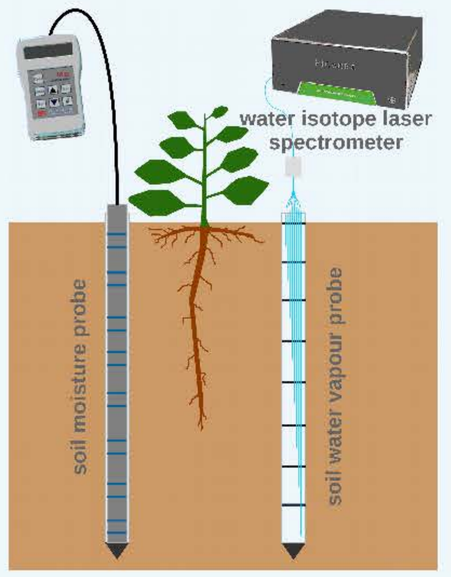
- Simulation with the model Hydrus 1-D
- Optimization of model parameters under consideration of observed soil moistures and stable water isotopes
- Simulated PWU source depth patterns depend on rarely known plant parameters
- Missing data to evaluate PWU simulation

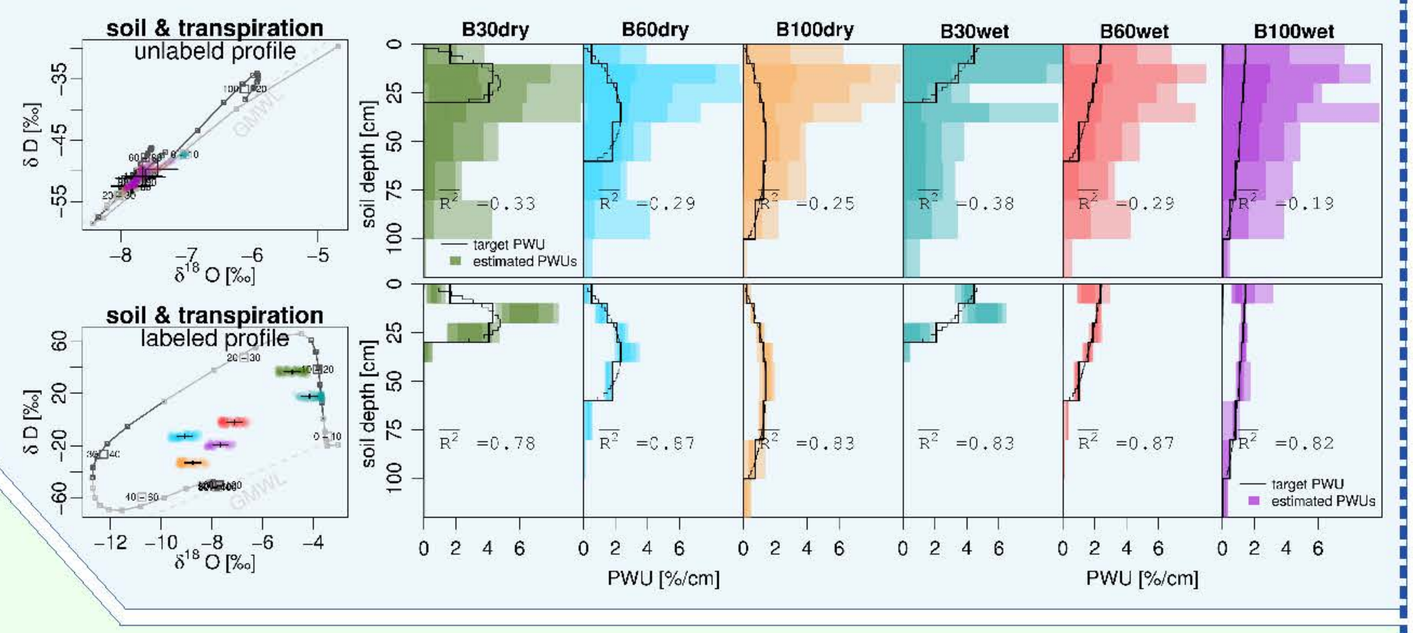
Soil hydraulic model simulation for a stand of Beech



Methods and preliminary results

- Use of mobile profile probes to measure volumetric soil water content and sample soil water vapour for stable water isotope analysis
- Identical access tubes for both profile probes (figure to the right) reduce cost and guarantee spatial agreement of measured values
- Additional measurement of plant transpiration and its stable water isotopes
- Application of isotopically distinct labelling pulses clearly improves PWU source depth estimates (figure below)





Study site *Flugplatz* in June 2016

- Field site at Flugplatz Freiburg
- Planted in June 2015
- 28 plots measuring 1.3m x 1.3m
- Two to six species (of 16) per plot
- Different plant physiological traits, like deep or shallow rooting and low or high leaf masses
- Roof structure above the plots allows for precipitation reduction

Next steps

- Finalization of the development of the soil water vapour profile probe
- Lab experiments to test the devised PWU source depths identification procedure
- Field site measurement campaign in summer 2017 to identify PWU source patterns for all 28 study plots under wet and dry conditions
- Comparison of PWU source depth patterns under particular consideration of the effects of plant trait diversity
- Investigation of the ability of commonly used models to reproduce the observed PWU source depth patterns
- Exploration of the observed PWU source depths pattern's implications on the water cycle

Professur für Hydrologie, Albert-Ludwigs-Universität Freiburg
stefan.seeger@hydrology.uni-freiburg.de www.hydro.uni-freiburg.de