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How do meteorological variables and topography control species-specific water uptake strategy along a forested hillslope?

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In the face of current global warming conditions, temperate forest ecosystems are expected to be strongly affected by temperature increase and more frequent and intense water shortage. This leads to severe stress for forest vegetation in many temperate systems. Therefore, understanding the vegetation water use in temperate forests is urgently needed for more effective forest management strategies. Root water uptake (RWU) is a species-specific trait (tree physiology and root architecture) and its spatio-temporal patterns are controlled by a range of site-specific (e.g., topography, geology, pedology) and meteorological factors (e.g., temperature, soil humidity, rainfall.

In the present study, we use stable water isotopologues as ecohydrological tracers combined with continuous measurement of hydrometeorological (weather variables, groundwater levels, soil moisture, streamflow) and physiological (sap flow, radial stem growth) parameters to investigate the spatio-temporal dynamics of water uptake for beech (Fagus sylvatica L.) and sessile oak (Quercus petraea (Matt.) Liebl) trees along a hillslope in a Luxemburgish catchment.

Fortnightly field campaigns were carried out during the growing season (April-October) 2019 to sample water from xylem, soil water at different depths, groundwater, stream water, and precipitation. Soil water isotopic composition and xylem water were extracted via cryogenic distillation. Grab sampling was performed for the other water pools. The isotopic composition was determined through laser spectroscopy and mass spectrometry (for xylem samples only).

From preliminary results, the isotopic composition of xylem water shows a marked seasonal variability suggesting a plasticity in RWU or a change in the isotopic composition of the water pools over the growing season. Moreover, beech and oak trees exhibit different uptake strategies when water supply is low. Within the range of observed groundwater variation topography does not play a statistically significant role on RWU.