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Detecting spatio-temporal controls on depth distributions of root water uptake using soil moisture patterns

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Landscape scale soil moisture patterns show a pronounced shift when plants become active during the growing season. Soil moisture patterns are then not only controlled by soils, topography and related abiotic site characteristics as well as site characteristic throughfall patterns but also by root water uptake.

In this study root water uptake from different soil depths is estimated based on diurnal fluctuations in soil moisture content and was investigated with a setup of 15 field sites in a forest in northeastern Germany. These sites cover different topographic positions and forest stands. Vegetation types include pine forest (young and old) and different deciduous forest stands. Available data at all sites includes information at high temporal resolution from 5 soil moisture and soil temperature profiles, matric potential, piezometers and sapflow sensors as well as standard climate data. The resulting comprehensive data set of depth distributed root water uptake shows differences in overall amounts as well as in uptake depth distributions between different forest stands, but also related to slope position and thus depth to groundwater. Temporal dynamics of signal strength within the profile suggest a locally shifting spatial distribution of root water uptake depending on water availability. The relative contributions of the different depths to overall root water uptake shift as the summer progresses. However, the relationship of these depth resolved uptake rates to overall soil water availability varies considerably between tree species. This unique data set of depth specific contributions to root water uptake down to a depth of 2 m allows a much more detailed analysis of tree response to water availability than the more common transpiration estimates generated by sapflow or eddy flux measurements.