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Tracking the diurnal signal of plant water uptake through the hydrologic system

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Plant water uptake during summer is characterized by strong diurnal fluctuations. As a result a diurnal sink term is imposed on catchment storage, affecting the unsaturated zone, sometimes the saturated zone and even streamflow. Detecting this signal and understanding its propagation through the hydrological system may help to better quantify eco-hydrological connectivity.
The extent and strength of the propagation of this signal from plant to soil to ground- and stream water was investigated with a unique setup of 46 field sites in Luxemburg and 15 field sites in Germany. These sites cover a range of geologies, soils, topographies and types of vegetation. Vegetation types include grassland, pine forest (young and old) and different deciduous forest stands. Available data at all sites includes information at high temporal resolution from 3-5 soil moisture profiles, matrix potential, piezometers and sapflow sensors (as proxy for plant water uptake) as well as standard climate data. At sites with access to a stream, discharge or water level is also recorded. Signal strength (amplitude of diurnal fluctuations) can thus be traced through the system and gives an indication of the physical sphere of influence of plant water uptake i.e. the “eco-hydro-connectivity”. Temporal dynamics of signal strength furthermore suggest a shifting spatial distribution of root water uptake with time. The analysis of time lags (or phase shifts) between daily fluctuations in temperature, radiation, sapflow, soil water, groundwater and streamflow gives further insights into the processes driving and propagating these signals and inter-site comparison allows for the investigation of local controls.