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Estimating evapotranspiration in different rain-fed peatlands from groundwater level changes

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Biogeochemical processes in peatlands are strongly controlled by the hydrological conditions of these environments. One of the key parameters controlling the water balance is the evapotranspiration, which can be calculated e.g. by the FAO crop reference evapotranspiration or the Penman-Monteith equation as a function of atmospheric conditions and plant specific parameters. These parameters are well investigated for agricultural crops and forests but poorly for most peatland vegetation types. Direct measurement of the evapotranspiration is possible with weighing lysimeters or the eddy-covariance technique, but expensive and time consuming. In many peatlands and riparian areas groundwater table changes are characterized by diurnal fluctuations (daytime decline, night-time recovery) caused by the evapotranspiration and groundwater recharge. White introduced 1932 a method to calculate the evapotranspiration from these diurnal fluctuations. In contrast to traditional evapotranspiration models only a small number of variables need to be measured (groundwater level changes, possibly precipitation) or calculated (specific yield). Over the last decades, several studies and modifications of the White method have been published.

Several authors showed the applicability of the method for riparian areas and fens, but this relies on the assumption of a constant recharge over the whole day. As there is no groundwater inflow at rain-fed peatlands, recovery during night-time can only result from redistribution in the soil profile or from lateral flow processes within the peatland. Thus, approaches to calculate evapotranspiration from diurnal groundwater fluctuations used to date need to be adapted. Based on 50 hydrographs measured in 6 rain-fed peatlands in Germany characterized by different soil properties, land use and vegetation, we systematically analyzed diurnal patterns of the groundwater levels. These patterns were spatially and temporally very variable. At some sites, the groundwater level continuously declined during rain-free periods with different slopes during the night and the day, resulting in a step-like shape of the hydrograph. Other sites showed a continuous decline at daytime followed by weakly increasing or constant groundwater levels at night. Based on this analysis, we developed a modification of the White-method for estimating the evapotranspiration of rain-fed peatlands. The approach will be validated with eddy-covariance data from one site.