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Estimating riparian zone evapotranspiration from streamflow fluctuations

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We analysed diurnal stream flow fluctuations during low flow periods driven by evapotranspiration in a 64 ha catchment in Austria. The data suggest there is separation of scales in the time domain as there are short scale (diurnal) fluctuations and long scale (seasonal) fluctuations of low flows with little variability in between. This is interpreted as being related to separation of scales of the controls in the space domain with two distinctive zones driving the transpiration effects on low flows. It is suggested that the evapotranspiration of the riparian zone connected to the groundwater gives rise to the diurnal fluctuations; the entire catchment is decoupled from the stream and leads to the seasonal fluctuations; and there are little intermediate controls. We propose a model to estimate the lag times associated with both time scales from the runoff data, and analyse their evolution throughout the year. The model provides an excellent fit to the low flow fluctuations during most of the year but during winter the fit is not as good because of the smaller amplitudes. There is a clear switching behaviour in spring when the fluctuations start and in autumn when the frost stops the fluctuations within days. The lag times between solar radiation and the low flow fluctuations increase from about 6 hours in spring to about 13 hours in autumn which is interpreted as being related to the lower soil moisture state and hence longer response times in autumn. These lag times are related to the riparian zone response. The recession time scales during low flow periods increase from about 40 days in spring to about 100 days in autumn. Again, the interpretation of the increase is the decreasing storage of subsurface water, however, at the catchment scale. The implications of these findings for modelling catchment systems at multiple scales are discussed.