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Diurnal stream flow fluctuations during low flow conditions along a stream reach - effects of transpiration

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We analysed diurnal fluctuations in the stream flow during low flow periods in a 64 ha. experimental catchment in Lower Austria. Detailed discharge measurements in a one minute time interval at different locations along the stream show diurnal fluctuations during low flow situations. The hypothesis is that the diurnal fluctuations are caused by the transpiration on two different scales, where the hydrograph at the catchment outlet shows short scale (diurnal) fluctuations and long scale (seasonal) fluctuations during low flow situations.
The separation of the two time scales is assumed to be closely connected to separation of scales in the space domain, where there are two distinct zones causing the transpiration effects on the stream flow. The zone responsible for diurnal fluctuations is suggested to be the riparian zone connected to the groundwater, which consist of deciduous forest and is decoupled from the rest of the catchment. The seasonal fluctuations are caused by the rest of the catchment, which consist of agricultural fields.
Additional data show that tributaries and drainage systems that flow through the deciduous forest also show diurnal fluctuations, where the drainage systems coming from the agricultural fields show now diurnal fluctuations. This phenomenon strengthens the hypothesis of two decoupled scales, where the diurnal fluctuations are caused by the riparian zone. In addition the effect of transpiration in low flow situations on different sections of the stream were examined. A model is proposed to estimate the lag times for both time scales and their evolution throughout the year. The model preformed an excellent fit for periods in the growing season, the model efficiency varied from 0.7 to 0.95.
The lag times between the maximum of the global radiation and the minimum flow increase from 6 hours in spring to approximately 13 hours in autumn, which is related to lower soil moisture state and therefore less connectivity between the groundwater and the roots. A third model parameter estimates the efficiency of the plants on the conversion of energy into transpiration, which is connected to amplitude of the diurnal fluctuations. The model parameters as well as time of maximum discharge and mean discharge are correlated to weather variables, such as wind speed, vapour pressure deficit and temperature.