Quantifying spatial and seasonal variations of groundwater-surface water interaction for the prediction of hydrological turnover on the catchment scale

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Targeting hypohreic exchange as well as gains and losses as the means of interaction between ground- and surface water in a stream leads forward to the consideration of both influencing the apparent hydrological turnover at the catchment scale i.e. the cumulative effect of gains and losses on physical water composition along a stream. The variability in hydrological turnover across a catchment is governed by the spatially varying connectivity between groundwater and the streambed. Especially under low flow conditions, expansion of turnover relative to stream flow is prominent and its spatial variability is intensified.

Studying the scaling behaviour of hydrological turnover processes, we measured hydrological turnover along two representative stream segments of about 500-600m length at a second order tributary to the river Mosel in Trier, western Germany by applying differential salt dilution gauging (after Payn et al., 2009) over 10 campaigns in summer and 7 in winter. Each stream reach represents a typical geomorphological setting in the catchment. The upstream reach is characterized by steep sloping terrain towards the stream with pastures and forest at higher elevations as the dominant land use. At the downstream reach the terrain is flatter with the stream meandering. The land use is diverse with meadow, pastures and forest as well as settlements. Each respective reach was split into two equidistant parts, resulting in three measurements of hydrological turnover, first and second section as well as the whole reach. Thus, acquiring data accounting for the spatial variability in each reach as well as between reaches. The measurements were carried out weekly, at the two stream reaches from August to September with stream flow ranging from ca. 2 l/s to 94 l/s and at the downstream reach from November to February with stream flow ranging from 200 l/s to over 1000 l/s.

The results show clearly the positive relationship between discharge and the relative volume of water exchanged between stream, hypohreic zone and groundwater as gains and losses at the reach scale. In addition to that, exchange processes vary independently at both investigated reaches. However, the dataset suggests a distinctive relationship between turnovers of an entire reach compared to the sum of the two sub-reach sections. The slope of this relationship may be a first step for the upscaling of observed exchange and turnover processes from the reach to the network scale.