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Characterizing retention processes in streams using retention metrics

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ABSTRACT

The temporal retention in storage zones (SZs) has a strong influence on mass transport processes in natural streams. It has been shown that solute retention affects solute breakthrough curves (BTCs) by producing longer tails and thereby increasing their skewness. In terms of ecological effects, this retention increases the contact time of solute with aquatic interfaces and living species, which can lead to degradation of eco-systems when the transported substances are pollutants. An important question that arises is whether the currently available metrics can adequately represent complex retention processes. In this study, we examine the performance of two existing metrics: the hydrological retention factor (RH) and the fraction of median travel time due to transient storage (Fmed). The results presented are based on two conservative tracer tests. The tracer tests were performed in streams with distinct morphological, sediment composition, vegetation and hydraulic characteristics. The recorded concentration-time series were used to derive storage zone parameters such as storage zone area, exchange coefficient and mean residence time. The storage zone parameters were computed using a multiple storage zone model STIR with two separate exponential residence time models for transient storage, representing short timescale (STS) and long timescale storage (LTS) processes. The retention metrics were estimated separately for short and long timescale retention, and for the combined retention. The cross-correlation between the retention metrics and the storage parameters was analyzed using Pearson's R- and significance p-values. In general, the results reveal a poor correlation between retention metrics and storage zone parameters, except for the exchange rate associated with long timescale storage, $\alpha 2$. A strong cross-correlation is instead found between the retention metrics.