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# Regionalization of mean transit times in montane catchments using pedological, topographic and climatic controls: a tool for process conceptualization.

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Mean transit time (MTT) is being increasingly used as a metric of catchment hydrological function and a tool in process conceptualization. Estimating MTT usually involves relating the temporally varying input concentration of a conservative tracer to the signal in the stream, using models of various transit time distributions (TTD). Most studies so far have been confined to single sites or to a small number of nested catchments with data collection periods of no longer than 1-2 years. This may limit the significance and transferability of the findings as such short periods usually only capture a narrow range of the climatic variability within a spatially restricted area. In this study, we use, for the first time, long-term (>10 year) data sets of hydrochemical tracers from 19 headwater catchments (ranging in size from 1 - 35km2), in seven geomorphologically and climatically distinct parts of the Scottish Highlands. In each catchment, weekly samples of precipitation and stream water with measured chloride concentrations were used to estimate the MTT using various TTD models within an uncertainty framework. The MTTs obtained from a Gamma Distribution model were the best identified and ranged from 40 to 1500 days for individual catchments. Moving window analysis revealed that at least 4 years data were needed to gain consistent MTT estimates. Shorter observation periods could produce widely ranging estimates, reflecting inter-annual climatic variability. The constrained MTTs estimated from long-term data at a wide range of contrasting sites, which cover a wide range of pedological, topographic and climatic characteristics, allowed a robust identification of first order controls on MTT in the analyzed headwater catchments. Multiple regression analysis was used to identify the relative importance of these topographic, pedological and climatic controls. The best model combines the prediction variables percentage responsive (i.e. overland flow generating) soil cover, drainage density, precipitation intensity and topographic wetness index and yields R2adj = 0.88. Cross validation shows small absolute error suggesting that the model can be used to estimate MTTs with relatively low uncertainty in ungauged headwater catchments throughout the whole region of the Scottish Highlands, and potentially in similar mountainous regions where no tracer information is available.