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Spatiotemporal relationship of DOC and NO_3- in ground- and surface water of a forested headwater catchment – investigated through correlation, transit times and wavelet analyses –

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Understanding natural controls on nitrogen (N) and carbon (C) biogeochemical cycles in time and space is important to estimate human impacts on these cycles. We examined the spatiotemporal relationships between time series of weekly monitored stream- and groundwater N and C (assessed by nitrate; NO_3- and dissolved organic carbon; DOC) in the forested Wüstebach catchment (Germany) over a 4-year period (2009- 2013). Median travel transit times (MedTTs) were used to connect hydrological and water chemistry data. In addition to traditional correlation analysis, we applied Wavelet Transform Coherence (WTC) to study variations in the correlation and lag-time between the N and C time series for different time scales.

Based on our results, we distinguished three streamwater groups with the following characteristics: (i) subsurface runoff dominated locations with negative C/N correlations, short time lags, strong seasonal fluctuations in concentrations, and short transit times, (ii) groundwater dominated locations, with weaker C/N correlations and lags of several months, small fluctuations in concentrations and longer transit times and (iii) intermediate locations, with moderate seasonal fluctuations, strong C/N correlations, short time lags and moderate transit times.

We identified water transit times as key drivers for the relationships in each group and conclude that C and N transport in stream water can be explained by the mixing of groundwater and subsurface runoff.

In conclusion, our study revealed that DOC, NO_3- concentrations and their ratio in Wüstebach stream waters can be explained by hydrological mixing processes. Complemented with transit times, and hydrochemical time series, the WTC analysis allowed us to discriminate between different water sources (groundwater/subsurface runoff). Overall, we find that in hydrochemical time series studies, e.g. of DOC and NO_3-, as in our study, WTC analysis can be a viable tool to identify spatiotemporally dependent relationships in catchments.