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Exceeding the limitations of watershed outlet sampling: Multi-approach analysis of synoptic streamwater chemistry data

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Catchment hydrology and biogeochemistry understanding has benefitted tremendously from improvements in temporal and spatial sampling frequency. However, we are just beginning to utilize the power of high-resolution time series from a few locations combined with high spatial density sampling often referred to as synoptic sampling. Coupling snapshot-in-time data across a landscape or stream network with high temporal frequency sampling at a few locations is not trivial and requires synthesis of methods, approaches, and research design with consideration for the strengths of empirical, statistical, and modeling methodologies.

Here we present multi-approach analysis of hydrologic and streamwater chemistry data across a 200 km2 catchment to demonstrate the insights gained from each successive analysis approach. Our analyses include but are not limited to 1) examining spatial/temporal nutrient speciation and stoichiometry, 2) analyzing dual isotopes of nitrate (15N and 18O) for source apportionment, 3) spatial linear modeling, 4) quantifying seasonality in spatial statistics/patterns, 5) quantifying sub-catchment nutrient loading and retention (budgets), 6) analyzing landscape and land cover / use, and 7) modeling nutrient source apportionment while characterizing and constraining predictive uncertainty in a Bayesian framework. We seek to demonstrate how combining multiple sampling designs with the strengths of multiple analyses can lead to new insights into processes operating across space and time at the catchment scale and help to identify the internal factors controlling behavior observed at the catchment outlet.