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Spectral scaling of hydrochemical responses – decomposition of water quality time series

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Knowledge of the different processes affecting the biogeochemical cycling of compounds transported with water, such as nutrients, contaminants and different forms of organically and inorganically bound carbon, is fundamental for understanding and assessing the water quality of any given surface water systems. However, these governing processes are often difficult to quantify, partly due to the complex dynamics of the governing physical and biogeochemical mechanisms, which span over a wide range of temporal and spatial scales. Here we present a recently developed analytical technique that separates the spectrum of time scales in a physically based transport model by relating the fluctuations in the forcing boundary conditions (i.e. the load function) to the water quality response.

By transforming the transport problem from the time domain into the frequency domain, closed-form solutions were obtained and used to derive compound specific formal expressions of the power spectral response for different hydrological systems including both a single stream reach and a network of interconnected transport pathways. The frequency dependent response, defined as the spectral scaling function, was subsequently used to evaluate concentration time series of water quality parameters on different spatial scales. This spectral decomposition attributes the water quality response in specific intervals of frequencies to governing processes and provides an opportunity to investigate/quantify the competing processes affecting the different compounds important for the water quality response.