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# Is fractal 1/f scaling in stream chemistry universal?

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Stream water chemistry data from catchments worldwide suggest that catchments act as filters that transform white noise, i.e. random, input signals such as in precipitation, into 1/f$\alpha$ noise whose slope in a power spectrum typically ranges between -0.5>$\alpha$>-1.5. This previously lead to the hypothesis that catchments act as fractal filters. In other words, it was posed that considering uncertainty, a slope of $\alpha$=-1 may be a universal and intrinsic property of catchments. Such fractal scaling characteristics would have considerable implications on the predictability of stream water chemistry, as both, temporal short- and long-range interdependence and memory control the system response. While short memories and thus flatter slopes with $\alpha$ closer to 0 indicate poor short term but good long-term predictability, steeper slopes with values of $\alpha$ «-1 indicate the opposite. In fractal systems, i.e. where $\alpha$=-1, this therefore leads to inherent problems of robustly predicting both, short and long-term response patterns.

The hypothesis of catchments acting as fractal filters ($\alpha$=-1), however, remains to be tested more profoundly. It is, for example, not yet clear, if the observed inter-catchment variations in $\alpha$ indeed need to be interpreted as uncertainty and noise in the signal or if the variations underlie a systematic pattern and can be explained by some characteristic of catchment function, as was recently suggested in a modelling study based two experimental catchments (Hrachowitz et al., 2015).

Here we will therefore further test the hypothesis that the spectral slope of stream water chemistry is not necessarily $\alpha$=-1 and that catchments therefore do not inherently act as fractal filters. Further, it will be tested if closer links between the variations in spectral slope and hydrological function of catchments can be identified.

The combined data-analysis and modelling study uses hydrochemical data (i.e. Cl- and O-18) from a wide range of catchments worldwide to allow a robust inter-comparison of response characteristics. The high number of study catchments is chosen to represent physically contrasting catchments in distinct climate zones, distinct landscape types and with distinct vegetation patterns. To identify potential patterns in the variations of $\alpha$, firstly the power spectra of the observed stream chemistry in the study catchments are compared with physical catchment characteristics using statistical methods such as cluster analysis. In a subsequent step, the stream water dynamics of the study catchments are modeled using integrated catchment-scale conceptual models. Catchments for which the observed spectral signature can be meaningfully reproduced by the model, are used for further analysis, relating the model-internal flux and state dynamics to variations in $\alpha$, to explore if systematic links between different flow processes and a can be established.