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Detection of flood events in hydrological discharge time series

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The shortcomings of mean-squared-error (MSE) based distance metrics are well known (Beran 1999, Schaeffli & Gupta 2007) and the development of novel distance metrics (Pappenberger & Beven 2004, Ehret & Zehe 2011) and multi-criteria-approaches enjoy increasing popularity (Reusser 2009, Gupta et al. 2009). Nevertheless, the hydrological community still lacks metrics which identify and thus, allow signature based evaluations of hydrological discharge time series.

Signature based information/evaluations are required wherever specific time series features, such as flood events, are of special concern. Calculation of event based runoff coefficients or precise knowledge on flood event characteristics (like onset or duration of rising limp or the volume of falling limp, etc.) are possible applications. The same applies for flood forecasting/simulation models. Directly comparing simulated and observed flood event features may reveal thorough insights into model dynamics. Compared to continuous space-and-time-aggregated distance metrics, event based evaluations may provide answers like the distributions of event characteristics or the percentage of the events which were actually reproduced by a hydrological model. It also may help to provide information on the simulation accuracy of small, medium and/or large events in terms of timing and magnitude.

However, the number of approaches which expose time series features is small and their usage is limited to very specific questions (Merz & Blöschl 2009, Norbiato et al. 2009). We believe this is due to the following reasons: i) a generally accepted definition of the signature of interest is missing or difficult to obtain (in our case: what makes a flood event a flood event?) and/or ii) it is difficult to translate such a definition into a equation or (graphical) procedure which exposes the feature of interest in the discharge time series.

We reviewed approaches which detect event starts and/or ends in hydrological discharge time series and thereupon propose a definition for flood events of discharge time series typically found in humid central european catchments. Based on this definition (our perceptual model), we developed a fuzzy based model for the detection of event starts. The two-step approach first derives time series properties and characteristics. The second step evaluates the distributions of these characteristics and applies sampled percentile values to fuzzy membership functions which decide whether any point of the time series of interest is an event start or not. We combined the procedure of our event start detection with a slightly modified version of the constant-k approach (Blume et al. 2007). This way they allow hydrological meaningful and reproducible flood event detection in hydrological discharge time series.

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