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Identification of river lowflows using a new data-based mechanistic method of optimal spectral decomposition

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Existing definitions of the slow component of river discharge (produced by the resurgence of deep groundwater) are rarely based on the spectral properties of the data. Estimation of this river discharge component is important, as it is a measure of the river resources available for public water supply abstraction during dry periods and a measure of the state of the groundwater reserves. Previous methods used to characterise the slow component of river discharge range from using complex geophysical models with mutivariate data, to simple hydrograph separation methods. We present a novel approach to slowflow estimation using a simple spectral decomposition of river discharge data into a transfer function causal dynamics driven by precipitation, and a slower additive component estimated using a combination of Kalman Filtering and Fixed Interval Smoothing, equivalent to regularisation. The combination of regularisation and transfer function model identification is optimised in an iterative relaxation procedure. We demonstrate the value of this new approach against commonly used alternative methods, and the consistency of the timing of the dynamics of the slowflow component with water-level responses measured in deep boreholes.