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The Wavelet ToolKat: A set of tools for the analysis of series through wavelet transforms. Application to the channel curvature and the slope control of three free meandering rivers in the Amazon basin.

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The form and functioning of a geomorphic system result from processes operating at various spatial and temporal scales. Longitudinal channel characteristics thus exhibit complex patterns which vary according to the scale of study, might be periodic or segmented, and are generally blurred by noise. Describing the intricate, multiscale structure of such signals, and identifying at which scales the patterns are dominant and over which sub-reach, could help determine at which scales they should be investigated, and provide insights into the main controlling factors.

Wavelet transforms aim at describing data at multiple scales (either in time or space), and are now exploited in geophysics for the analysis of nonstationary series of data. They provide a consistent, non-arbitrary, and multiscale description of a signal's variations and help explore potential causalities. Nevertheless, their use in fluvial geomorphology, notably to study longitudinal patterns, is hindered by a lack of user-friendly tools to help understand, implement, and interpret them.

We have developed a free application, The Wavelet ToolKat, designed to facilitate the use of wavelet transforms on temporal or spatial series. We illustrate its usefulness describing longitudinal channel curvature and slope of three freely meandering rivers in the Amazon basin (the Purus, Juruá and Madre de Dios rivers), using topographic data generated from NASA's Shuttle Radar Topography Mission (SRTM) in 2000. Three types of wavelet transforms are used, with different purposes. Continuous Wavelet Transforms are used to identify in a non-arbitrary way the dominant scales and locations at which channel curvature and slope vary. Cross-wavelet transforms, and wavelet coherence and phase are used to identify scales and locations exhibiting significant channel curvature and slope co-variations. Maximal Overlap Discrete Wavelet Transforms decompose data into their variations at a series of scales and are used to provide smoothed descriptions of the series at the scales deemed relevant.