Improvement of a rainfall-runoff model with multiresolution analysis

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Transfer function-based models are widely used in rainfall-runoff modeling. These models simulate discharges, using the convolution between rainfall rates and a transfer function. Most often, rainfall-runoff models are linear and suffer from lack of physical meaning.

The rainfall-runoff model introduced here is versatile. It has up to four parallel branches. Each branch consists of an input convoluted by up to three transfer functions. The output is the sum of the convolution products. The number and the type of transfer functions are chosen for every simulation.

Four probability density transfer functions are available: Gamma distribution, normal distribution, Beta distribution and power-law distribution. Each one represents a physical phenomenon. For example, the Gamma distribution also known as the Nash model represents a cascade of n linear reservoirs.

This model is non-linear because of its architecture with several branches. It has up to twenty-eight parameters: one per branch and two per transfer function. They are calibrated with a particle swarm optimization algorithm.

To deal with non-stationarity issues, a multiresolution cross-analysis is performed. The input signal is decomposed in different scales, using a discrete wavelet transformation. Then, a cross-correlation is calculated between these sub-signals and the output. The aim is to identify which scales of the rainfall rates are correlated with the discharge, and which are not.

Once uncorrelated scales are identified, they are removed from the input signal. This filtered input is used to calibrate the model during calibration periods. This method should improve the model efficiency during validation periods.