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Calibration of hydrological models in the spectral domain: a chance for ungauged basins?

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This contribution considers the possibility to use the Whittle's approximation to the Gaussian maximum likelihood function for estimating the parameters of hydrological models. This method was proposed by Whittle in 1953, in the context of time series analysis, and was mainly used for calibrating stochastic models so far. Roughly speaking, the calibration is carried out by comparing the periodogram of the data simulated by the model with the periodogram of the available observations. Whittle's likelihood allows to account for correlation in the model's residuals and provides asymptotically consistent estimates for Gaussian and non-Gaussian data, even in the presence of long-range dependence. This latter is deemed to be a possible explanation for the well-known Hurst effect, that sometimes may affect hydrological records. Whittle's likelihood presents a relevant advantage: in principle, model calibration can be performed even in absence of observed data. In fact, the only information required by the Whittle's likelihood is the periodogram of the process, which can be inferred by using an alternative information, like old and sparse records, regional information and so forth. This latter behaviour of the Whittle's estimator constitutes a interesting chance for the implementation to ungauged/scarcely gauged catchments. The proposed procedure is applied to the case study of a Italian river basin, for which a lumped rainfall-runoff model has been calibrated without using contemporary rainfall and river flow data. It is shown that the Whittle's estimator can be successfully applied within the GLUE methodology, therefore being a potentially useful tool for the application of hydrological models in the presence of equifinality.