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Calibrating hydrological models in the spectral domain: Inference of parameter uncertainty using a Metropolis algorithm

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A discharge time series, being the results of the integration of complex hydrological processes, corresponds to an overlay of several individual patterns, each of which encodes how the relevant input processes (e.g. rainfall) are filtered by the hydrological system. Estimating and analyzing the frequency content of the observed discharge time series can therefore help gaining information about these filtering effects and the underlying physical processes. Hydrological models can be calibrated in the spectral domain by fitting the estimated spectrum of the simulated time series to the estimated spectrum of the observed time series. For certain hydrological modelling applications, such a calibration in the spectral domain can show some advantages compared to traditional curve fitting. It can for example make use of information provided by old and sparse data that is difficult to include in a traditional curve fitting calibration procedure. This additional information can be supposed to contribute to decrease the parameter uncertainty for the calibration of hydrological models that are not well identifiable by considering the time domain only. The estimation of parameter uncertainty is, in fact, a key issue of calibration in the spectral domain. This method can provide asymptotically consistent estimates for Gaussian and non-Gaussian data whereas confidence limits for the estimated parameters can at present be derived only for Gaussian data. This is a considerable drawback for many hydrological records that are often far from being Gaussian, especially those observed at fine time scales. In this study we present a procedure for the estimation of parameter uncertainty for hydrological models calibrated in the spectral domain: We use a Metropolis-Hastings algorithm in conjunction with the Gaussian likelihood function proposed by Whittle. This estimator has nice

statistical properties, namely, it is asymptotically consistent and unbiased, and has already been shown to satisfactorily perform for hydrological models. We present first results and further research perspectives.