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Uncertainty estimates by Bayesian method with different likelihood functions and in hydrological models with varying time scales

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In hydrological modelling Bayesian revision is widely used in uncertainty assessment. With respect to model calibration, parameter estimation and analysis of uncertainty sources, various regression and probabilistic approaches have been used in different models calibrated at different time steps. None of these applications however focuses on comparisons of uncertainty analysis in hydrological models with varying time scales. This study pursues a comprehensive evaluation and comparison of uncertainty assessments by Bayesian revision using the Metropolis Hasting (MH) algorithm with the hydrological model WASMOD with a daily and monthly time steps. In the daily step model three likelihood functions are used in combination with Bayesian revision: i) the first order autoregressive AR (1) process plus Normal time period independent model (Model 1), ii) the AR (1) plus Normal time period dependent model (Model 3) and iii) the AR (1) plus multi-normal model (Model 2). In addition a novel index called the Percentage of observations bracketed by the Unit Confidence Interval (PUCI) is used for uncertainty evaluation. The results reveal that it is more important to consider the autocorrelation in daily WASMOD rather than monthly WASMOD. Firstly, the resulting goodness of fit of the daily model vs. observations as measured by the Nash-Sutcliffe efficiency value is comparable with that calculated by the optimization algorithm in monthly WASMOD. Secondly, the AR (1) model is not sufficiently adequate to estimate the distribution of residuals in daily WASMOD since PUCI shows that Model 2 outperforms Model 1. Furthermore, the posterior distribution of parameters derived from Model 2 is more accurate as measured by Nash-Sutcliffe efficiency value. Third, Model 3 performs best over the entire flow range, while Model 2 outperforms Model 3 only for high flows. This shows that additional statistical parameters reflect the statistical characters of the residuals more efficiently and accurately. Fourth, by considering the difference in terms of application and computational efficiency it becomes evident that Model 3 performs best for daily WASMOD. Model 2 on the other hand is superior for daily time step WASMOD if the auto-correlation of parameters is considered.