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Evaluation of rainfall uncertainty in hydrological modelling under different rain gauge density

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Traditional treatment of input uncertainty in hydrological modelling is implemented by specifying an error model for rainfall input with some parameters to be calibrated. However, these error models are rarely validated based on observed rainfall data, and unreasonable error model parameters may be resulted from the hydrological model calibration process. This study aims to analyze the influence of rain gauge density and distribution on hydrological modelling uncertainties. Firstly, multiplicative error models for different rain gauge density are established and validated using rainfall data from Xiangjiang River basin which has a dense rain gauge network. Then these input error models are coupled with a deterministic lumped hydrological model, the Xinanjiang model, to analyze the model uncertainty caused by the model input error. After that, the total model uncertainties including input, model parameter and output uncertainty are analyzed by Bayesian method using the Metropolis Hasting algorithm. Finally, the influence of rain gauge density and distribution on model uncertainty is evaluated and discussed by analyzing the 95% confidence interval of model simulations considering the input uncertainty with different rain gauge density. The results show that: 1) lognormal multiplicative error model is suitable for describing the rainfall errors when the mean areal rainfall is larger than a specified threshold; 2) with the increase of rain gauge density, the variance of rainfall error is decreased as well as the model input uncertainty; and 3) however, due to the interaction of input uncertainty, parameter uncertainty and output uncertainty, no significant improvement of the model total error uncertainty is observed with further increase of rain gage density.