Data and Parameter Uncertainty of VIC Model Using GLUE and BMC Techniques: Case Study in Diyala River Basin in Iraq

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Abstract. One of the most challenging issues that hydrologists encounter in water resources planning and management is determining model parameter uncertainty and examining parameter sensitivities to the system response. This analysis can only be achieved if accurate forcing data and basin data are assembled from several different data sources. The main objectives of this study are to (1) implement a complete and accurate forcing data for Diyala river Basin in Iraq and test the validity of Tropical Rainfall Measurement Mission (TRMM) and Variable Infiltration Capacity model (VIC) data sets, and (2) quantify the uncertainty of the VIC model parameters in Diyala River Basin in Iraq. Diyala River is a tributary of the Tigris River in eastern Iraq. Its total length and basin area are about 216.5 km and 16,763.7 km^2, respectively. Due to limited availability of observed daily data, a random temporal cascade method is applied to downscale the monthly precipitation into daily with the aid of a transformation technique. Furthermore, generalized linear regression equations are developed to adjust the VIC temperature data depending on the observation data. The coefficients of the developed linear equations are computed based on each basin grid geometry and utilizing Kriging transformation technique. The sensitivity and identifiability of the VIC model are evaluated using Generalized Likelihood Uncertainty Estimation (GLUE) and Bayesian-Monte Carlo (BMC) techniques. Seven candidate parameters of the VIC model (i.e., B_infiltration, Ds, Ws, Dsmax, and depths of soil layer 1, 2, and 3) associated with the infiltration and surface runoff production processes are examined. The analyses indicated that neither the observations from TRMM nor the VIC modeled data is accurate for gridded precipitation. TRMM tends to underestimate the precipitation amount whereas the VIC data tends to be higher than the allowable observations. Therefore, a temporal downscaling technique is applied. Moreover, the comparison between four different interpolation techniques reveals that the Kriging method is superior. The optimal model performance is found with NSCE values of 0.686 and 0.688 for the calibration and verification period, respectively. The optimal model residuals are also tested for normality, heteroscedasticity, and correlation. In addition, the results of the GLUE and BMC analyses imply that the depth of the second soil layer is the most sensitive parameter, and B_infiltration, Dsmax, and soil depth of the first soil layer are relatively insensitive. The Ds, Ws, and third Soil Depth are insensitive parameters.