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Uncertainty analysis of a snowmelt runoff model using Markov Chain Monte Carlo (MCMC) approach

Faisal Baig (1,2) and Zuhal Akyurek (1)

(1) Department of Civil Engineering, Middle East Technical University, Ankara, Turkey, (2) Department of Agricultural Engineering, Bahauddin Zakariya University, Multan, Pakistan

Mountainous watersheds have always remained a challenge for the modelers due to ample variations taking place in those watersheds. The key reason could be the lack of ground observations and model parameter uncertainty. Generalized Likelihood Uncertainty Estimation (GLUE) approach is used widely to account for the parameter uncertainty only. However, appraisal of other sources of uncertainty is likewise important such as, forcing data uncertainty, model structural errors etc. This study employs Markov Chain Monte Carlo (MCMC) sampler, entitled Differential Evolution Adaptive Metropolis (DREAM) algorithm to account for the forcing data uncertainty, and a comparison is made with the formally used GLUE approach. A conceptual, degree day snow melt model, NAM is used to simulate the snow melt runoff of Ilgaz basin located in the northern part of Turkey and having 28.4km2 area. Mean elevation is around 1700 m and the basin is covered with broad leaf forest while the main soil is brown soil having high water holding capacity. Instead of daily precipitation and evapotranspiration (ET) values, individual storms and monthly ET values are optimized in combination with model parameters, and corrected values of the input forcing data are used for the calibration (2013-2016 water years) and validation (2017 water year) purposes. Results showed an over estimation in the observed precipitation values by almost 10% while an under estimation in the evapotranspiration values calculated by Penman Monteith method. The mean values of storm and ET multipliers are obtained as 1.14 and 0.84 respectively. Considering only parameter uncertainty, both GLUE and DREAM could not give Nash-Sutcliffe (NSE) values greater than 0.64, while an improved value of NSE (0.84) is obtained when explicit treatment of forcing data error is done using DREAM approach. Calibration of the model along with careful treatment of forcing data errors provided reasonable prediction uncertainty bounds and well shaped posterior distribution of NAM model parameters. Despite using a conceptual model, the physical meanings of the model parameters are also discussed.