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Sensitivity Analysis to uncertain Parameters of TopModel in Tropical Regions with application to the Middle Magdalena Valley (Colombia)

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Management of uncertainty in hydrologic modeling is related to our ability to (a) select appropriate values for model parameters and (b) assess the extent to which their variation affects a simulated response. We focus on the application of sensitivity and uncertainty analyses to assess the influence of main parameters associated with the widely used distributed watershed model TopModel in estimating surface runoff in the area of the Middle Magdalena Valley, Colombia. We ground our study on the GLUE methodology, as included in the MCAT Toolbox. This methodology is conducive to a Regional Sensitivity Analysis (RSA), rendering global information about the relative importance of given model parameters through an a-posteriori probability function. GLUE is viewed as a first step to undertake a comprehensive global sensitivity analysis based on the statistical moments characterizing the outputs of the simulations. We do so upon relying on (a) the Sobol' indices, associated with a classical decomposition of variance and (b) recently developed indices quantifying the relative contribution of each uncertain model parameter to the (ensemble) mean, skewness and kurtosis of the model output. Our analyses are grounded on a collection of 150.000 model simulations, each spanning a 12-year temporal window. These are constructed by assuming those model parameters are random and associated with a uniform distribution within a support of width selected on the basis of literature studies and preliminary model calibration against available data. Results of the global sensitivity analysis enable identifying a reduced set of model parameter values, showing that the parameter driving the transmissivity recession curve (associated with an exponential decrease of saturated hydraulic conductivity with depth), the maximum root zone storage deficit, and the initial subsurface flow can be considered as the most sensitive ones. Observed and simulated high values of surface runoff due to the excess of infiltration suggest a high water storage capacity of the soil and dominance of subsurface runoff processes, consistent with the local characteristics of the soils in the region.