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Are average hydraulic parameters representative? A stochastic analysis of water balance components predicted by a hydrological model

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Vadose zone hydrological models employing finite difference numerical solutions of the Richards equation allow simulating the movement and predicting the state of soil water and associated quantities in the vadose zone. Robust algorithms are available to perform such simulations and most numerical issues with these have been solved. Parameters describing the relation between hydraulic conductivity K, pressure head h, and water content θ determine the quality of model output. We performed two case studies, one with maize in the southeast of Brazil (São Paulo State) evaluating a wet-year and a dry-year scenario, and one with soybean in the northeast of Brazil (Maranhão State). Parameters of the Van Genuchten-Mualem (VGM) relations were obtained from laboratory evaporation experiments with undisturbed soil samples. The parameter uncertainty was expressed as standard error and correlations between parameters were expressed in a correlation matrix. A previously developed stochastic framework was used to evaluate the outputs of the SWAP hydrological model according to the uncertainty and correlations in the VGM parameters. Performing runs with 10^5 stochastic realizations per scenario, we evaluated the predictions of evaporation, transpiration, bottom flux, and runoff and their frequency distribution with respective crops at both locations. Results will be discussed and show that no general conclusion can be drawn about the frequency distributions of soil water balance components as a result of the uncertainty of and correlation between VGM parameters. Skewed or multimodal distributions of output parameters are common, and the most commonly performed prediction using the average VGM parameter values does not always agree to the mean or median of stochastic realizations. Users of hydrological models should be aware of this propagation of uncertainty and correlation into the model outputs. The investigation of the representativeness of average VGM parameters in specific scenarios adds to the interpretation of the predictive power of hydrological models.