A General Probabilistic Framework for uncertainty and global sensitivity analysis of deterministic models: A hydrological case study

Abstract:
The present study proposes a General Probabilistic Framework (GPF) for uncertainty and global sensitivity analysis of deterministic models in which, in addition to scalar inputs, non-scalar and correlated inputs can be considered as well. The analysis is conducted with the variance-based approach of Sobol/Saltelli where first and total sensitivity indices are estimated. The results of the framework can be used in a loop for model improvement, parameter estimation or model simplification. The framework is applied to SWAP, a 1D hydrological model for the transport of water, solutes and heat in unsaturated and saturated soils. The sources of uncertainty are grouped in five main classes: model structure (soil discretization), input (weather data), time-varying (crop) parameters, scalar parameters (soil properties) and observations (measured soil moisture). For each source of uncertainty, different realizations are created based on direct monitoring activities. Uncertainty of evapotranspiration, soil moisture in the root zone and bottom fluxes below the root zone are considered in the analysis. The results show that the sources of uncertainty are different for each output considered and it is necessary to consider multiple output variables for a proper assessment of the model. Improvements on the performance of the model can be achieved reducing the uncertainty in the observations, in the soil parameters and in the weather data. Overall, the study shows the capability of the GPF to quantify the relative contribution of the different sources of uncertainty and to identify the priorities required to improve the performance of the model. The proposed framework can be extended to a wide variety of modeling applications, also when direct measurements of model output are not available.

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