Applying Screening Tools to Speed the Evaluation of Uncertainty in Sediment Transport Models

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Abstract. Hydraulic and sediment-transport models are widely used to predict future conditions in natural rivers and to analyze the impacts of potential changes to water systems. Unfortunately, the results of these models contain uncertainty due to uncertainty in the model inputs, the values of the model parameters, and the mathematical representation of the system. Computational Bayesian methods have been extensively researched to assess the uncertainty caused by uncertain parameters. However, these methods require too many model simulations to be used with hydraulic and sediment-transport models that require significant computation time for each simulation. This study explores a new approach to make the parameter uncertainty methods quicker. Bayesian uncertainty methods typically assume that the modeler has no prior knowledge aside from the feasible bounds for the parameter distributions, but a modeler can potentially determine the parameters that have more or less effect on the model results before application of the uncertainty analysis method. To explore this possibility, a screening tool is designed to evaluate the sensitivity of the model outputs to the parameters and determine which parameters can be neglected in the uncertainty analysis. An elementary effect test is conducted to quantify the importance of each parameter on the model outputs, and a LH-OAT (Latin Hypercube and One factor at A Time) method is used to efficiently sample the parameters over the feasible space. Parameters that introduce much variation in the model outputs are treated as uncertain, while parameters with little effect on model outputs are treated as certain and neglected in the uncertainty analysis. The revised algorithm for Bayesian uncertainty estimation is tested by coupling it to a sediment transport model called SRH-1D, which is widely used in assessments of aquatic habit among other applications. The model is then applied to two published flume experiments (an erosional and a depositional case). The benefits of using the screening method are evaluated by comparing the number of required simulations and the estimates of forecast uncertainty to those of existing uncertainty estimation methods. Overall, the results suggest that using the screening method can substantially reduce the number of required simulations while still producing similar estimates of the forecast uncertainty. However, the number of required simulations still remains relatively large.