Assessing Uncertainty due to the Selection of a Sediment Transport Equation Using Univariate and Multivariate Bayesian Model Averaging

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Abstract. Sediment transport models such as Sedimentation and River Hydraulics - One Dimension (SRH-1D) contain uncertainty from a variety of sources including the mathematical equation that is used to compute the river's sediment transport capacity. No single equation is applicable to all fluvial conditions. Bayesian Model Averaging (BMA) combines the predictions from multiple models to produce deterministic and probabilistic forecasts. It aims to reduce the effects of imperfections in a single model prediction and to characterize the uncertainty due to the mathematical model structure. Unfortunately, BMA is limited to cases that consider a single output variable (univariate BMA). This limitation is potentially important in sediment transport modeling because multiple variables such as bed profile, grain size, and volume of sediment load are usually investigated at the same time. The objective of this research is to implement a multivariate version of BMA and compare the uncertainty in the predictions when the model uncertainty is estimated based on single and multiple output variables. To produce the multivariate BMA, the likelihood function of univariate BMA is modified to calculate the likelihoods of each model using multiple variables. The BMA methods are compared by coupling them to SRH-1D, and four sediment transport equations in SRH-1D are used to compute the transport capacity for non-cohesive material. SRH-1D is then applied to two published flume experiments for both erosional and depositional cases with non-cohesive materials. Variables with available measurements are treated as the outputs of interest. These include bed profile, grain sizes (D16, D50, and D84), and the mass of sediment load. The univariate and multivariate BMA methods are evaluated by comparing the accuracy of their forecasts and the coverage of the observations by their credible intervals. Overall, the results demonstrate that the both univariate and multivariate BMA provide improved predictions over the individual transport equations, and the multivariate BMA presents more accurate forecasts than univariate BMA.