Foundational methods for model identification and uncertainty analysis

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Abstract: Abstract Before embarking on formal methods of uncertainty analysis that may entail unnecessarily restrictive assumptions and sophisticated treatment, prudence dictates exploring one's data, model candidates and applicable objective functions with a mixture of methods as a first step. It seems that there are several foundational methods that warrant more attention in practice and that there is scope for the development of new ones. Ensuing results from a selection of foundational methods may well inform the choice of formal methods and assumptions, or suffice in themselves as an effective appreciation of uncertainty. Through the case of hydrological models of varying complexity from several watersheds we illustrate that there are valuable methods, many of them already in open source software, others we have recently developed, which can be invoked to yield valuable insights into model veracity and uncertainty. The hydrological case is an instructive one for wider classes of models. We show results of using methods of data analysis to investigate signals present in data before modelling, including cross-correlation analysis, deconvolution and filtering techniques. We also demonstrate global sensitivity analysis methods that help: determine whether insensitive parameters impact on predictions and therefore cannot be fixed; and identify which combinations of objective function, dataset and model structure allow insensitive parameters to be estimated. And we apply response surface and polynomial chaos methods to yield knowledge of the models' response surfaces and parameter interactions, thereby informing model redesign.

Keywords: *Data analysis, sensitivity analysis, response surface, polynomial chaos*