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Control of uncertainty in complex hydrological models via appropriate schematization, parameterization and calibration

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The recent expansion of complex, distributed modelling schemes results in significant increase of computational effort, thus making the traditional parameter estimation problem extremely difficult to handle. Recent advances provide a variety of mathematical techniques to quantify the uncertainty of model predictions. Despite their different theoretical background, such approaches aim to discover “promising” trajectories of the model outputs that correspond to multiple, “behavioural” parameter sets, rather than a single “global optimal” one. Yet, their application indicates that it is not unusual the case where model predictive uncertainty is comparable to the typical statistical uncertainty of the measured outputs, thus making the model validity at least questionable. Uncertainty is due to multiple sources that are interacted in a chaotic manner. Some of them are “inherent” and therefore unavoidable, as they are related to the complexity of physical processes, necessarily represented through simplified hypotheses about the watershed behaviour. Other sources are though controllable via appropriate schematization, parameterization and calibration. This involves adaptation of the principle of parsimony, appropriate distributed models and incorporation of hydrological experience within the parameter estimation procedure. The above issues are discussed on the basis of a conjunctive modelling scheme, fitted to two complex hydrosystems of Greece. A parsimonious structure is made possible by spatial analysis that is consistent with the available data and the operational requirements regarding water management, and the correspondence of model parameters to the “broad” physical characteristics of each system. Within the calibration strategy, the key concept is to exploit any type of knowledge, including systematic measurements as well as additional information

about non-measured model outputs, in a multi-response optimization framework. The entire approach contributes to a significant reduction of uncertainties, as indicated by successful validation results.