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Automatic Calibration of Hydrological Models in the Newly Reconstructed Catchments: Issues, Methods and Uncertainties

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The use of optimisation methods has a long tradition in the calibration of conceptual hydrological models; nevertheless, most of the previous investigations have been made in the catchments with long period of data collection and only with respect to the runoff information. The present study focuses on the automatic calibration of hydrological models using the states (i.e. soil moisture) as well as the fluxes (i.e., AET) in a prototype catchment, in which intensive gauging network collects variety of catchment variables; yet only a short period of data is available. First, the characteristics of such a calibration attempt are highlighted and discussed and a number of research questions are proposed. Then, four different optimisation methods, i.e. Latin Hypercube Sampling, Shuffled Complex Evolution Metropolis, Multi-Objective Shuffled Complex Evolution Metropolis and Non-dominated Sort Genetic Algorithm II, have been considered and applied for the automatic calibration of the GSDW model in a newly oil-sand reconstructed catchment in northern Alberta, Canada. It is worthwhile to mention that the original GSDW model had to be translated into MATLAB in order to enable the model to be automatically calibrated. Different conceptualisation scenarios are generated and calibrated. The calibration results have been analysed and compared in terms of the optimality and the quality of solutions. The concepts of multi-objectivity and lack of identifiability are addressed in the calibration solutions and the best calibration algorithm is selected based on the error of representing the soil moisture content in different layers. The current study also considers uncertainties, which might occur in the formulation of calibration process by considering different calibration scenarios using the same model and dataset. The interactions among accuracy, identifiability, and the model parsimony are addressed and discussed. The present investigation concludes that the calibration of conceptual hydrologic models using the catchment states and/or fluxes is indeed a multi-objective optimisation task with a great lack of identifiability according to the shortage of the data measurement as well as of the model structural insufficiency, which might not be able to represent both states and fluxes using similar parametric values. Among the optimisation techniques implemented, Non-dominated Sort Genetic Algorithm II (NSGA-II) is assigned as the most promising tool for model calibration considering the characteristics of the problem in hand. In addition, by decreasing the number of objective functions it would be possible to significantly improve the model identifiability in both parametric and objective spaces without compromising the model accuracy in representing the dominant catchment scale states and fluxes.