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Coupling HYDRUS-1D Code with PA-DDS Algorithms for Inverse Calibration

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Numerical modelling requires calibration to predict future stages. A standard method for calibration is inverse calibration where generally multi-objective optimization algorithms are used to find a solution, e.g. to find an optimal solution of the van Genuchten Mualem (VGM) parameters to predict water fluxes in the vadose zone. We coupled HYDRUS-1D with PA-DDS to add a new, robust function for inverse calibration to the model. The PA-DDS method is a recently developed multi-objective optimization algorithm, which combines Dynamically Dimensioned Search (DDS) and Pareto Archived Evolution Strategy (PAES). The results were compared to a standard method (Marquardt-Levenberg method) implemented in HYDRUS-1D. Calibration performance is evaluated using observed and simulated soil moisture at two soil layers in the Southern Abbotsford, British Columbia, Canada in the terms of the root mean squared error (RMSE) and the Nash-Sutcliffe Efficiency (NSE). Results showed low RMSE values of 0.014 and 0.017 and strong NSE values of 0.961 and 0.939. Compared to the results by the Marquardt-Levenberg method, we received better calibration results for deeper located soil sensors. However, VGM parameters were similar comparing with previous studies. Both methods are equally computational efficient. We claim that a direct implementation of PA-DDS into HYDRUS-1D should reduce the computation effort further. This, the PA-DDS method is efficient for calibrating recharge for complex vadose zone modelling with multiple soil layer and can be a potential tool for calibration of heat and solute transport. Future work should focus on the effectiveness of PA-DDS for calibrating more complex versions of the model with complex vadose zone settings, with more soil layers, and against measured heat and solute transport.

Keywords: Recharge, Calibration, HYDRUS-1D, Multi-objective Optimization