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Inverse coupled simulation of soil water flow and surface runoff

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Vadose zone water dynamics and surface runoff are mutually dependent. We coupled a 1D overland flow model to the 2D subsurface flow HYDRUS-2D model. The increased parameter demand of the flow model was addressed by utilizing AMALGAM; a recently developed multiobjective global search method. The model performance was evaluated using bench-scale flow experiments conducted with two 5-m long replicate soil channels. Surface runoff and subsurface drainage waters were sampled at three outlet ports equally spaced along the channels. The model simulation results showed that a good match between measured and observed surface runoff and total drainage does not guarantee accurate representation of the flow process. An inspection of the Pareto results of different multiobjective calibration runs revealed a significant trade-off between individual objectives, showing that no single solution existed to match all data equally well. There was no single optimal solution even when accounting for an observed surface crust and immobile water regions. Discrepancies between model simulations and soil channel experiments suggest the presence of unknowns, such as heterogeneity of the hydraulic soil properties. The coupled model was found to be a versatile tool for studying subsurface flow and surface runoff over soils.