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An Improved Representation of The Variable Contributing Area Concept in Hydrologic and Land Surface Models

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Hydrologic modelling in the low-lying, flat prairie or arctic pothole regions is challenging because of variable contributing areas that modify the transformation of local runoff into streamflow. Most hydrological and land surface models fail in predicting prairie hydrology due to overlooking or inadequately representing the variable contributing area dynamics. In this study, we develop an open-source, model-agnostic version of a revised formulation of the recently developed Hysteretic Depressional Storage (HDS) model. This revised formulation accounts for the hysteretic relationship of pothole depressions and its effects on streamflow generation. The revised HDS model is implemented and tested with two different hydrological models of varying complexity (MESH and HYPE). The modified hydrological models are tested on a number of prairie pothole basins in Canada. Results show improved simulations of the streamflow response in the tested basins. Importantly, the modified models replicate the known hysteretic relationships between depressional storage and contributing areas in that region. The open-source HDS implementation approach is designed for use in hydrologic or land surface modelling systems, enabling improvements in simulating the complex hydrology and streamflow regimes globally.