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Improving discharge forecast skill of lowland hydrological models using Ensemble and Unscented Kalman filtering

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Hydrology in lowlands is affected by processes such as groundwater-unsaturated zone coupling, wetness-dependent flow routes, groundwater-surface water feedbacks, and seepage and surface water supply. For operational water management in lowlands and polders (for instance in the Netherlands), models as WALRUS and SOBEK-RR are used for flow prediction, often as an input to real-time control algorithms to steer water with pumps and weirs to keep water levels within acceptable bounds. Therefore, good initialization of these models is important. Here, we test both Ensemble (EnKF) and Unscented (UKF) Kalman filter using low-dimensional lumped hydrological catchment models. EnKF has received much attention in the field of hydrology due to its relative simplicity and robustness when addressing the nonlinear filtering problem. UKF has its origin in transforming the Gaussian random variables (GRV) for nonlinear estimation in a deterministic way and has received little attention in the context of state estimation of conceptual hydrological models. We conducted a reforecast experiment for a period of ten years using an hourly time step. The experiments were conducted within Delft-FEWS using OpenDA-SOBEK. The results show that both UKF and EnKF can improve the accuracy of the discharge forecast by assimilating the discharge. The setup and methods are suitable for implementation in an operational context.

Key words: Ensemble Kalman Filter; Unscented Kalman Filter; State Estimation;
Lowland Catchments; Conceptual Hydrological model; Wageningen Lowland Runoff Simulator