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Dual Extended Kalman Filter in retrieving effective soil hydraulic properties by surface soil moisture assimilation

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Retrieving soil moisture profiles from surface data assimilation in soil hydrological models has to cope with the uncertainty in the soil hydraulic parameters. Some studies have proved that, in case of poorly identified soil hydraulic parameters, model predictions may even be worse than model estimates without data assimilation. Therefore, the sequential estimation of both states and parameters from noisy signals is a fundamental prerequisite for suitably addressing the underlying challenge. The dual Extended Kalman Filter (EKF) has proved, at least theoretically, to be an efficient technique for generating approximate maximum-likelihood estimates of both states and parameters of a discrete-time nonlinear dynamic system. The objective of this work is to evaluate the accuracy of the dual EKF for retrieving soil moisture profiles and soil hydraulic parameters simultaneously by the assimilation of moisture-related surface data in a one-dimensional simulation hydrologic model. Parameters under scrutiny were the saturated hydraulic conductivity, Ks, as well as parameters "α" and "n" describing the shape of the van Genuchten water retention relation. The present study provides useful insights on the implementation of the dual EKF into computer models applied to the vadose zone hydrology. The sensitivity of dual EKF results to several computational aspects is evaluated with numerical experiments. An effective procedure is proposed for getting efficient predictions even for high errors of the initial state and parameter values. The parameter convergence is affected more than the depth of the observations within the soil profile than by the initial state and parameter values.