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A Particle Smoother with Sequential Importance Resampling for soil hydraulic parameter estimation: A lysimeter experiment

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An adequate description of soil hydraulic properties is essential for a good performance of hydrological forecasts. So far, several studies showed that data assimilation could reduce the parameter uncertainty by considering soil moisture observations. However, these observations and also the model forcings were recorded with a specific measurement error. It seems a logical step to base state updating and parameter estimation on observations made at multiple time steps, in order to reduce the influence of outliers at single time steps given measurement errors and unknown model forcings. Such outliers could result in erroneous state estimation as well as inadequate parameters. This has been one of the reasons to use a smoothing technique as implemented for Bayesian data assimilation methods such as the Ensemble Kalman Filter (i.e. Ensemble Kalman Smoother). Recently, an ensemble-based smoother has been developed for state update with a SIR particle filter. However, this method has not been used for dual state-parameter estimation.

In this contribution we present a Particle Smoother with sequentially smoothing of particle weights for state and parameter resampling within a time window as opposed to the single time step data assimilation used in filtering techniques. This can be seen as an intermediate variant between a parameter estimation technique using global optimization with estimation of single parameter sets valid for the whole period, and sequential Monte Carlo techniques with estimation of parameter sets evolving from one time step to another. The aims are i) to improve the forecast of evaporation and groundwater recharge by estimating hydraulic parameters, and ii) to reduce the impact of single erroneous model inputs/observations by a smoothing method. In order to validate the performance of the proposed method in a real world application, the experiment is conducted in a lysimeter environment.