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Estimation of evaporation fluxes and soil hydraulic parameters by combining an Ensemble Kalman Filter with an inversion

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Hydrologic modeling of unsaturated soils faces the challenge of uncertainties in the hydraulic states, the measurements, the applied initial and boundary conditions and in the description of the mathematical model itself.
To combine the available but incomplete information into a consistent model, data assimilation techniques, such as the Ensemble Kalman Filter (EnKF) introduced by Evensen [1994], found increasing popularity because of their ability to assess both the hydraulic states and the material properties simultaneoulsy, accounting for these uncertainties. Especially the determination of the evaporation from the soil surface is highly inaccurate. Thus we investigate the suitability of the EnKF to estimate the evaporative boundary forcing on the basis of a subsurface Time Domain Reflectometry (TDR) time series.
In this study we use the software muphi (Ippisch et al. [2006]) to solve the Richards equation in a 1D soil profile. The EnKF is applied for the state estimation of the water content. Additionally, the information gained during the analysis step of the EnKF is used to correct the evaporation. In combination with an inversion using fitphi (Ippisch et al. [2006]) for parameter estimation, evaporation and parameters are improved in an iterative way. We demonstrated the successful operation of the algorithm on a synthetic test case with water contents measured in different depths. We also showed that the uniqueness of the parameter set describing the observations depends on the width of the hydraulic states measured.