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Joint assimilation of soil moisture and eddy covariance data with the particle filter in the HYDRUS model

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Observational data are assimilated in land surface models to improve model predictions and parameter estimation. The assimilation of latent heat flux measured by the eddy covariance method is not yet very common, and therefore the value of eddy covariance data is explored in this study. The sequential importance resampling (SIR) particle filter is used here to test in a synthetic experiment the assimilation of eddy covariance data and/or soil moisture data in the HYDRUS model. The advantage of using the particle filter for the assimilation of eddy covariance data is that EC data can be incorporated directly without the need for a linearization step. HYDRUS simulates flow in the unsaturated zone by solving the Richard's equation with a Mualem-van Genuchten parameterization. Our analysis focused on the characterization of soil moisture and evapotranspiration, and the estimation of soil hydraulic parameters. In data assimilation experiments, both model forcings and soil hydraulic parameters (the Mualem-van Genuchten parameters α, and n, besides hydraulic conductivity (Ks)) were uncertain. EC-measurement errors were modeled using an error model (based on the extended two-tower approach) applied on real EC-data. Studies were carried out for three homogeneous soil types (loamy sand, silt and loam) and two different layered soils from the Rollesbroich site and Selhausen site (North-Rhine Westphalia, Germany). Results show that EC-data contribute to characterization of soil hydraulic parameters, especially under dry conditions. Best results are obtained for the joint assimilation of EC-data and soil moisture data. Results are relatively insensitive to the EC-measurement error.