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Assimilation of multiscale soil moisture data into an integrated land surface-subsurface model

Wolfgang Kurtz (1,2), Harrie-Jan Hendricks Franssen (1,2), Prabhakar Shrestha (3), Mauro Sulis (3), Klaus Goergen (2,3,4), Stefan Kollet (1,2,3), Harry Vereecken (1,2)

(1) Agrosphere (IBG-3), Institute of Bio- and Geosciences, Forschungszentrum Jülich GmbH, Germany, (2) Centre for High-Performance Scientific Computing in Terrestrial Systems, Forschungszentrum Jülich GmbH, Germany, (3) Meteorological Institute, University of Bonn, Germany, (4) SimLab TerrSys, Jülich Supercomputing Centre, Forschungszentrum Jülich GmbH, Germany

The coupling of land surface and subsurface models has been shown to lead to a better representation of state variables and fluxes which might improve the overall predictive accuracy of hydrological and atmospheric models. In general, predictions with such highly parameterized models are associated with a considerable degree of uncertainty due to the uncertain initial conditions and the poorly known subsurface and vegetation properties. An important variable of such systems is the soil moisture content which influences the partitioning of energy fluxes at the land surface and is highly variable in space and time. Information on soil moisture content is therefore essential for improving the predictive accuracy of integrated models, e.g. with respect to the estimation of latent and sensible heat fluxes from the land surface, regional water budgets and river discharge, and for constraining the associated uncertainties of these variables. Data assimilation techniques offer a stochastic framework to merge uncertain model predictions with observation data and to improve the estimation of uncertain model parameters. These techniques have already been used in the context of land surface modelling but the assimilation was usually restricted to one sensor type (i.e. scale) for soil moisture measurements (typically remote sensing data). However, soil moisture data can be derived from a variety of sensor types which operate at different spatial scales ranging from point measurements like TDR sensors (dm scale) over medium range measurements like cosmic ray probes (ha scale) to large scale measurements like satellite remote sensing products (km scale). Thus, the information content that is potentially available from different sensor types was not fully exploited until now. Moreover, these data types were in general not used to improve the parameterization of the land surface model and were only used to update states in real-time. In this work, we will present the conceptual framework for assimilating multiscale soil moisture observations into the integrated land surface-subsurface model Parflow-CLM with the ensemble Kalman filter. We will demonstrate the feasibility of this approach by applying the data assimilation system to the medium scale Rur watershed which is equipped with a dense monitoring network of point measurements of soil moisture and several cosmic ray stations which are distributed over the whole catchment area.