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A new assimilation scheme of near-surface soil moisture to identify effective soil hydraulic parameters

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Several distributed soil-vegetation-atmosphere transfer (SVAT) models, particularly those employed by meteorologists and climatologists, describe soil hydrological processes by assuming uniform soil hydraulic properties within relatively large spatial elements, neglecting sub-element heterogeneities in both horizontal and vertical dimensions and with the risk to fail of representing the surface forcing accurately. The soil hydraulic characteristics are to be interpreted as grid-effective parameters to provide a representation of the areal response in terms of state variables (e.g. average soil water content) and hydrological fluxes (evapotranspiration, infiltration, deep percolation, etc.). Recent developments in the measurement of surface soil water content by remote sensing have been opening new prospectives toward the parameterization of soil hydrological processes at grid scale. Several studies focused on the assimilation of surface data for retrieving soil moisture along a vertical soil profile and inferring on the root-zone soil water availability, but nearly always they neglected the inherent uncertainty in the effective soil hydraulic characteristics.

Through a combination of modeling and observations, in this study we present a technique to assimilate near-surface soil moisture observations that includes the soil hydraulic parameters into the set of retrieved variables. A non-linear Kalman filter is employed within a numerical solution of the Richards equation for simulating the vertical soil water dynamics in the vadose zone. The soil moisture data assimilation scheme allows for uncertainty in the observed soil moisture and is validated with data from evaporation tests performed on differently-textured soil cores. An initial guess

of the soil hydraulic parameters is obtained using pedotransfer functions commonly available in the literature. Comparisons between the soil hydraulic properties, obtained using both direct and inverse methods and the corresponding properties estimated with our new assimilation scheme show that the proposed technique overall provides useful insights in the parameterization of fluxes over heterogeneous land surfaces and can contribute to obtain more reliable output results from large scale SVAT modeling applications.