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Methodology for calculating equivalent field scale soil hydraulic system parameters taking into account hysteresis

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Most hydrologic model studies dealing with the simulation of integrated flow systems of stream and overland flow, soil water and solute movement in the unsaturated and saturated aquifer zones, need system parameters defined at grid scales bigger than local point scale. An appropriate answer on this scale-transfer question is vital for reliable and accurate modeling results. Only then, can these models provide end-users, implementers and policy makers with appropriate decision support.

This paper describes results obtained with a new methodology developed for the determination of field scale soil characteristic parameters obtained from inversing evapotranspiration flux data measured at field scale. A robust hysteresis model was used to organize data taken during both wetting and drying field transients through a unifying framework, without the need of starting from either full saturation or oven dryness. Details on the inverse methodology are given in a joint paper presentation. Testing and validation was carried out on data collected at the uniformly grass covered experimental site (900 m^2) of the Agricultural Faculty of the “Università degli Studi di Torino” at Grugliasco (Italy). Using Brutsaert’s evaporation model, field scale evapotranspiration fluxes were estimated from micro-meteorological data as net radiation and temperature and wind speed monitored at two height levels. For purposes of comparison, local scale infiltration and exfiltration data were calculated from simultaneously monitored soil water content and soil water pressure profiles using automatic TDR and tensiometer devices. The data chosen for this study are from the spring 2007.

Considering soil evaporation and grass transpiration together as one evapotranspiration term, local and field scale evapotranspiration fluxes compared favorably. The inverse technique applied to the field scale evapotranspiration fluxes together with use of the hysteresis module, resulted in equivalent field scale soil hydraulic system parameter estimates which were entirely consistent with parameter estimates determined from local scale data. This strongly suggests that there exists a larger scale Darcy's law which can be determined from local scale considerations.

This is an extremely useful and interesting result that may have far reaching implications for catchment scale hydrologic modeling.