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Using IR-measured soil surface temperatures to estimate hydraulic properties of the top soil layer

Christian Steenpass (1), Jan Vanderborght (1), Michael Herbst (1), Jirka Simunek (2), and Harry Vereecken (1)

(1) Institute of Chemistry and Dynamics of the Geosphere – Agrosphere, Forschungszentrum Jülich, Germany, (2) Department of Environmental Sciences, University of California Riverside, California, USA

The temporal and spatial development of soil surface temperatures (SST) depends on water availability in the near-surface soil layer. Since the soil loses latent heat during evaporation and water available for evaporation depends on soil hydraulic properties (SHP), the temporal variability of SST should contain information about the near-surface SHP. This study was conducted to investigate the information content of soil surface temperatures for estimation of soil hydraulic properties and their uncertainties, and to determine the effect of soil tillage on near-surface SHP. A hydrological model (HYDRUS-1D) coupled with a global optimizer (DREAM) was used to inversely estimate the van Genuchten-Mualem parameters of SHP from infra-red measured SST and TDR-measured water contents. The general applicability of this approach was tested using synthetic data. The same approach was then applied to a real data set, which was collected during September 2008 in Selhausen, Germany. The synthetic data set was generated using HYDRUS-1D for the same initial and boundary conditions and measurement protocol as the real data set. Using synthetic and real data it was found that although estimated SHP are sensitive to SST, their estimates are relatively uncertain when only information about SST is used. These uncertainties can be reduced by additionally considering also measured soil water contents. A comparison of SHP determined in the laboratory on undisturbed soil samples with those estimated from SST and TDR data measured in a harrowed soil showed similar results for the deeper undisturbed soil and large differences for the harrowed part of the soil profile. This shows the important effect of soil tillage on soil hydraulic properties. Application of the method in the field to characterize the hydraulic properties of the upper soil layer may reduce the amount of needed in-soil measurements and therefore allows larger scale observations.