Geophysical Research Abstracts
Vol. 18, EGU2016-845, 2016
EGU General Assembly 2016

Temporal changes of spatial soil moisture patterns: controlling factors explained with a multidisciplinary approach

Edoardo Martini (1), Ute Wollschläger (1,2), Simon Kögler (1,2), Thorsten Behrens (3), Peter Dietrich (1,2,4), Frido Reinstorf (5), Karsten Schmidt (3), Markus Weiler (6), Ulrike Werban (1), and Steffen Zacharias (1)

(1) Dept. Monitoring and Exploration Technologies, Helmholtz Centre for Environmental Research - UFZ, Leipzig, Germany (edoardo.martini@ufz.de), (2) WESS – Water and Earth System Sciences Competence Cluster, Tübingen, Germany, (3) Institute of Geography, University of Tübingen, Germany, (4) Centre for Applied Geoscience, University of Tübingen, Germany, (5) Department of Water and Waste Management, University of Applied Sciences Magdeburg-Stendal, Germany, (6) Chair of Hydrology, Albert-Ludwigs-University of Freiburg, Germany

Characterizing the spatial patterns of soil moisture is critical for hydrological and meteorological models, as soil moisture is a key variable that controls matter and energy fluxes and soil-vegetation-atmosphere exchange processes. Deriving detailed process understanding at the hillslope scale is not trivial, because of the temporal variability of local soil moisture dynamics. Nevertheless, it remains a challenge to provide adequate information on the temporal variability of soil moisture and its controlling factors. Recent advances in wireless sensor technology allow monitoring of soil moisture dynamics with high temporal resolution at varying scales. In addition, mobile geophysical methods such as electromagnetic induction (EMI) have been widely used for mapping soil water content at the field scale with high spatial resolution, as being related to soil apparent electrical conductivity (ECa). The objective of this study was to characterize the spatial and temporal pattern of soil moisture at the hillslope scale and to infer the controlling hydrological processes, integrating well established and innovative sensing techniques, as well as new statistical methods. We combined soil hydrological and pedological expertise with geophysical measurements and methods from digital soil mapping for designing a wireless soil moisture monitoring network. For a hillslope site within the Schäfertal catchment (Central Germany), soil water dynamics were observed during 14 months, and soil ECa was mapped on seven occasions whithin this period of time using an EM38-DD device. Using the Spearman rank correlation coefficient, we described the temporal persistence of a dry and a wet characteristic state of soil moisture as well as the switching mechanisms, inferring the local properties that control the observed spatial patterns and the hydrological processes driving the transitions. Based on this, we evaluated the use of EMI for mapping the spatial pattern of soil moisture under different hydrologic conditions and the factors controlling the temporal variability of the ECa-soil moisture relationship. The approach provided valuable insight into the time-varying contribution of local and nonlocal factors to the characteristic spatial patterns of soil moisture and the transition mechanisms. The spatial organization of soil moisture was controlled by different processes in different soil horizons, and the topsoil's moisture did not mirror processes that take place within the soil profile. Results show that, for the Schäfertal hillslope site which is presumed to be representative for non-intensively managed soils with moderate clay content, local soil properties (e.g., soil texture and porosity) are the major control on the spatial pattern of ECa. In contrast, the ECa-soil moisture relationship is small and varies over time indicating that ECa is not a good proxy for soil moisture estimation at the investigated site.Occasionally observed stronger correlations between ECa and soil moisture may be explained by background dependencies of ECa to other state variables such as pore water electrical conductivity. The results will help to improve conceptual understanding for hydrological model studies at similar or smaller scales, and to transfer observation concepts and process understanding to larger or less instrumented sites, as well as to constrain the use of EMI-based ECa data for hydrological applications.