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Implementation of a wireless sensor network for monitoring the long term soil water dynamics at the hillslope-scale.

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Knowledge of soil water dynamics at the field scale is an important issue e.g. for water management, understanding runoff generation processes, and for calibration and validation of soil water balance models. There is a clear need for robust and flexible monitoring technologies which are able to capture high-resolution information over large areas. Fast and precise measurements may be obtained from geophysical surveys and distributed in situ sensor networks.
The overall aim of the project is to design a spatially optimized monitoring strategy for hillslope-scale soil water dynamics by combining innovative geophysical methods and wireless soil moisture sensing technology.
In the Harz Mountains (Central Germany), a 2.5 ha hillslope area was permanently instrumented with a wireless soil moisture and soil temperature monitoring network (SoilNet). Along the slopes, lateral flows are expected to play a relevant role in the runoff process, and the different soil types respond differently to the meteorological forcing.
Based on Proximal Soil Sensing (PSS) data from geophysical surveys and the Digital Elevation Model (DEM) of the study site, a conditioned Latin Hypercube Sampling strategy (cLHS) was applied to select 30 locations for the SoilNet nodes. In order to intensify the observations at shorter distances, 10 additional locations were added to the network. In total, 40 network nodes, each comprising 6 sensors, were installed at 3 depths (two repetitions at 5, 25 and 50 cm), providing measurements with high spatial and temporal resolution.
A sensor-specific calibration was performed in order to enhance the accuracy of both, soil water content and soil temperature estimation. Therefore, each sensor of the node was calibrated in 7 fluids with several dielectric permittivities. Moreover, a mixture of ice and water was used for temperature calibration.
Data are measured at an hourly interval, transferred via UMTS connection, automatically processed and plotted, both as time series of each node and as spatial maps.
The specific calibration showed to improve the water content and temperature estimation. Calibrated spatial patterns in soil water content can be related well to the soil types present on the hillslope. The SoilNet, coupled with an appropriate sampling scheme, demonstrates to be suitable for high- resolution monitoring, despite some technical issues have to be considered.