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Heterogeneity of unsaturated flow measured in the dry summer of 2018 in Germany recorded by the combination of ERT and soil data

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In 2018 the weather in Germany was extreme: The highest temperatures since 1881 (= start of regular weather recording) were observed during the months of April – August (temperature anomaly of +3.6 K) and the second lowest precipitation amounts (anomaly of -150 mm). In that year, we measured the soil conditions (soil water tension, water content, electrical resistivity, temperature, seepage water at suction plates) in a maize field in Northern Germany continuously down to a depth of about 1.5 m using a combined geophysical and soil scientific small-scale instrumentation array.

This unique dataset revealed the heterogeneity of the subsurface water content, changes in soil water conductivity, heterogeneity of the water retention function, indications for preferential flow after the onset of precipitation (and locally increased nitrate concentrations) in seepage water. The electrical resistivity (ERT) data clearly detected the infiltration of local rainfall events by the change of near surface resistivity. The resistivity changes differ spatially reflecting dm-scale variations most probably caused by the dense maize plants. Soil water contents measured by TDR detected the summer rainfall events in some locations, in others, very small-scale preferential flow paths were found overlooked by ERT. The detected changes in pore water conductivity need to be taken into account when recalculating water contents from ERT data. Our data allow for a description of different scale effects on the derivation of flux processes and total flux estimations under extreme weather conditions but also show that cross-scale methods are needed for an adequate assessment of unsaturated flow.