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Spatial and temporal organization of soil moisture at the field scale as affected by soil management

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Soil water content (SWC) is a key variable for numerous physical, chemical and biological processes that take place at or near the surface. Therefore SWC is the principal link between the global energy, water and carbon cycles that govern the interactions between climate, soil and vegetation. A better representation of SWC variability could improve hydrological and meteorological predictions. This work aims at increasing our understanding of the dynamics and organization of SWC at the field scale, in order to optimise SWC measurement strategies to evaluate the hydrological consequences of contrasting soil management systems.

An experimental field in SW Spain, where conventional and no-till management are being compared in a wheat-sunflower-legume rotation on a Chromic Haploxerert soil (Vertisol), was periodically sampled at 54 locations for gravimetric SWC. Soil water retention curves were determined in the laboratory on minimally disturbed soil samples from each location.

The time-stable SWC pattern was calculated and the wettest and driest locations were identified, as well as the points that best represented the field-average SWC during the monitoring period. Spatial and temporal SWC variations were characterized and related with the soil management systems, topography and orientation. SWC was found to be significantly higher in the no-till plots throughout the monitoring period. Relationships between standard deviation, coefficient of variation, skewness coefficient, and spatially averaged SWC were determined for both soil management systems, with maximum variability at SWCs of 100-120 g/kg. Using these equations, the required number of measurement points to estimate the average SWC with certain reliability was estimated and showed that almost two times more points were required in conventional management with respect to no-till. The Brooks and Corey equation was fitted to the soil water retention data, showing significant differences between both management systems in the wet range (> -500 hPa) of the curves. Using the results from stochastic analysis of unsaturated flow in heterogeneous soil and the fitted Brooks and Corey parameters, the possibility of inferring the relationship between the standard deviation and SWC from soil water retention data only was evaluated.