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The importance of *in-situ* soil moisture observations to evaluate the main drivers of event runoff characteristics in a small-scale catchment

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A catchment's runoff response to precipitation largely depends on the antecedent soil moisture in the catchment, but also on hydro-meteorological conditions in terms of, e.g., evapotranspiration. Studies investigating the effects of hydro-meteorological conditions on runoff event characteristics at the small catchment scale with daily temporal resolution mostly used surrogate measures for soil moisture, e.g., derived from hydrological models or using the antecedent precipitation index (API). Here, we applied a time-series based pattern search to 11 years of daily *in-situ* measured soil moisture in three depths (5, 20, 50 cm) at 33 locations in the Rollesbroich catchment (40 ha) in Germany to identify key variables influencing runoff event characteristics under similar wetness patterns. After identifying wetness patterns, we split the corresponding runoff responses into similar and dissimilar ones by means of goodness-of-fit criteria and analyzed their respective hydro-meteorological variables and event runoff coefficients (ERC), i.e., the proportion of rainfall that transforms into runoff during an event. Results showed that for similar soil moisture patterns, mean potential evapotranspiration, and antecedent soil moisture in all three depths had a smaller standard deviation for similar runoff responses than for dissimilar. This indicates a larger influence on the runoff response compared to rainfall-derived variables such as total event rainfall, maximum event rainfall intensity, or API. Furthermore, during runoff events under similar wetness conditions, the Spearman rank correlation coefficient (ρ) indicated a low average correlation between ERC and API (ρ=0.17). In terms of antecedent soil moisture conditions, the highest correlation between ERC and antecedent soil moisture was observed in the topsoil at 5 cm depth (ρ=0.43), while at 20 cm (ρ=0.16) and 50 cm (ρ=0.30) depths, the correlations were comparatively lower. Our study indicates that using the API as a substitute for antecedent wetness conditions may not be able to comprehensively reflect the relation between the runoff response and antecedent soil moisture conditions in the topsoil in the given catchment. Consequently, the results show that topsoil moisture measurements are more suitable than the surrogate API for assessing the impact of hydro-meteorological variables on daily runoff characteristics.