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Modelling soil moisture spatial-temporal variability with 3-D physically-based hdrological model in central Italy

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Soil water content (SWC) evolution in space and in time influences many hydrological processes such as infiltration and run-off production, surface energy exchanges, floods and drought generation and propagation, triggering of shallow landslide. Modeling SWC is a complex task influenced by heterogeneity in precipitation, soil parameters, topography, and vegetation. In order to consider these different factors we used a three-dimensional process based hydrological model that solves the 3-D Richard equations, coupled with atmospheric energy exchanges, considering the radiative and turbulent fluxes. For the purposes of this study we modeled the surface SWC dynamics (of top 10-15 cm of soil) in a 60 km^2 watershed located in central Italy (Vallaccia catchment). In the basin were available: i) SWC measured continuously at hourly time step for 3-years (2002-2005), and ii) 35 daily SWC measures carried out within one year (from Nov-2006 to Nov-2007) in seven different fields consisting in a regular grid configuration of five by six nodes (grid-step of 10 m). Two were the objectives of the study. Firstly, the calibration of model parameters (hydraulic conductivity and van Genuchten parameters) in order to simulate long term SWC dynamics in time. The two long-term SWC time-series were split in two and used for model calibration and verification, respectively. Model performances reaches values of Kling-Gupta Efficiency of 0.85 in calibration and 0.78 in verification period, giving confidence of reliability for the estimation of the ungauged points. The second objective was the reproduction of SWC patterns in space in the seven different fields where measurements were collected. For each field, modeled and measured statistical moments (from the first to the fourth: mean, variance, skewness and kurtosis) were presented in the form of scatterplots and influence of the variability of the hydraulic conductivity in space on the overall SWC distribution was investigated by generation of different random-fields correlated in space.