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Longterm analysis of measured and simulated evapotranspiration and soil water contents of a period from 2003 to 2012 at the grass covered boundary layer field site Falkenberg, Germany

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In our study, we analysed a 10-years period with hourly rates of real evapotranspiration (ETr) measured by Eddy-Covariance (EC) and hourly soil water contents at depths from 8 cm down to 90 cm monitored by Time Domain Reflectometry (TDR)-probes at the grass-covered boundary layer field site Falkenberg operated by the Lindenberg Meteorological Observatory - Richard-Aßmann-Observatory of the German Meteorological Service (DWD). These ETr-rates and soil water contents were compared with the results of a modelling approach consisting of the FAO56-Penman-Monteith equation and of the soil water balance model Hydrus-1D using uncompensatory and a compensatory root water uptake (RWU) model with different parameters. Simulated and measured soil water contents above 90 cm depth and ETr-rates calculated by using uncompensatory RWU showed a good agreement. Compared to that, the application of a compensatory RWU-model led to a decrease in the simulation quality for ETr and soil water contents due to some mismatches between measured and simulated soil moisture values and ETr-rates particularly during dry summer periods. In spite of these mismatches, the results indicated that the modelling approaches used in our study enabled an adequate simulation of hourly ETr-rates and soil water contents. However, all RWU-approaches used in our study showed some limitations in dry years. Measured soil water contents at 90 cm depth indicated increased root growth and corresponding RWU in deeper and wetter soil layers of the perennial grass cover especially in the dry years 2003 and 2006. This impact of drought stress in dry years and the corresponding adaption mechanism of perennial grass cover can be simulated only with some limitations by assuming a given static root density distribution and a maximum rooting depth even if RWU-compensation is used. In general, this substantiated the necessity of the measurement of spatial root density distribution in the soil profile and maximum rooting depth at experimental fields with vegetation cover.