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Comparison of simulation results using HYDRUS-1D and model in CGMS for selected region GRID50 of the Czech Republic

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CGMS - Crop Growth Monitoring System developed by JRC is an integrated system to monitor crop behavior and produce timely and quantitative crop yield forecasts. It works on European scale. This study was performed within a framework of ASEMARS project (Actions in Support of the Enlargement of the MARS Crop Yield Forecasting System) lead by Alterra to asses a possible impact of simplifications of capacity based model for simulation of water flow in the soil profile in CGMS compare to a Richards equation based model. 16 scenarios were simulated using the Richards equation based model HYDRUS-1D (Simunek et al., 2005). Each scenario represents a single soil profile presented in the selected cell of GRID50 in the Czech Republic using SGDBE40 database. An equilibrium flow was assumed in all cases. Geometry of the soil profiles as well as the root distribution was defined according the data stored in the database. The soil hydraulic properties corresponding to each soil layer were defined assuming the class transfer rules proposed by Wosten et al. (1999). Single set of measured daily rainfall and calculated daily evaporation from the bare soil surface and transpiration of crop canopy stored in the CGMS database GRID_WEATHER were used. The bottom boundary conditions were defined as a free drainage or a constant water level 250 cm below the soil surface. The relative soil moisture (RSM) in the root zone during the vegetation period was calculated to be compared with the average RSM values that were calculated with CGMS. The RSM values for different soil profiles are considerably different depending on soil texture and root depth. The impact of the ground water table depends on soil texture and root depth as well. The average RSM values were calculated assuming the area of each soil typological units.

The RSM values obtained using HYDRUS-1D are higher then those obtained using CGMS due to the following reasons. First, the RSM values are dominantly influenced by values of field capacity that were defined as soil water content for pressure head of -20 kPa when calculated for HYDRUS-1D simulations. If the soil water contents for a higher pressure head were used lower values of RSM would be obtained. Secondly, the mathematical modeling with CGMS is based on an assumption of leakage from the simulated domain if the field capacity is exceeded. As result the water probably more quickly drains from the soil profile compare to HYDRUS-1D simulations when water drainage depends on boundary conditions and simulated conditions within the soil profile that caused higher retention ability of simulated soil profile. On the other hand in many real soil types a non-equilibrium water flow may appeared that causes quicker water percolation through the soil profile that is not described by used version of HYDRUS-1D. A module simulating the non-equilibrium water flow would have to be used in this case. Richards' equation based model allows for simulation of ground water table impact that may be very significant. While the first bottom boundary defined as a free drainage did not considerably influenced a water regime in the root zone, which was controlled mainly by atmospheric conditions, a second boundary condition defined as a constant water level 250 cm below the soil surface caused higher water storage in the root zone. HYDRUS-1D is a proper and precise tool for modeling soil water regime within the soil profile. This precision is maybe too high taking into account considered precision in CGMS (high profile simplification, calculation RSM value as an average value of wide range of RSM values for every soil typological units). However a possible application of this or any other Richards equation based model with proposed precisions/simplifications should be studied to obtain better view of water regime in the soil profiles especially in the case of the ground water impact and probably also for plant with high sensitivity to plant water stress.