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Modeling root elongation as a function of soil strength and biomass growth with a field-scale crop model coupled with a 3D architectural root model

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The accurate prediction of root growth and related resource uptake efficiency is crucial to accurately simulate crop growth especially under unfavorable environmental conditions such as drought or soils with compacted layers. As each individual root in a root system may show different elongation rates due to differences in root age and/or varying local soil stresses, we aimed at improving the prediction of crop growth of a 1D field-scale crop-soil water model (running in the modeling framework SIMPLACE) by coupling it with the 3D architectural root model CRootBox on a daily time step. Hereby, CRootBox obtains the maximal daily root elongation from SIMPLACE, and SIMPLACE receives the root length density (computed from the 3D explicit root architecture) from CRootBox. Due to the coupling, the root biomass provided by SIMPLACE determines the maximal root elongation (feedback loop). When the potential root elongation is higher than maximal, CRootBox reduces the root growth equally for each root tip. A decreased root length density may result in decreased soil water and nutrient uptake and an increased water-/nutrient stress in SIMPLACE which may reduce the total biomass production. Furthermore, we implemented a root stress function which describes root elongation as a function of soil strength. The coupling of the models and simulation tests showing differences of spring wheat root growth and yield under different conditions will be presented. Moreover, we calibrated and validated the coupled model on a data set of a field trial on a soil with a compacted soil layer and a treatment where subsoil loosening was performed.