Description of the master’s thesis

Root water uptake plays a major role in various agricultural challenges, for example, in water and pesticides management or crop production. To understand the uptake behavior of plants, the modeling of root-soil interactions is helpful to analyze the interacting processes between soil and plant roots. This Master’s Thesis aims at understanding water flow processes to and into the root when different soil types are used and when additional evaporation takes place. The simulation results from the first step shall be used to prepare experimental setups using the wind-channel at the Colorado School of Mines in Golden.

The main tasks are:

Setup simulation scenarios with one plant root system, surrounded by bare soil compartments. The plant is able to take up and transpire water, but the soil top-boundaries are closed (no evaporation). The water flow in the system is analyzed based on different soil and root properties. In soil, homogeneous as well as heterogeneous soil properties are used. The root is parametrized with different axial and radial conductivities.

Simulation scenarios allowing for evaporation from the bare soil are run. The effect of evaporation is implemented via boundary conditions, defined at the top of the porous medium domain. These boundary conditions account for the formation of a turbulent boundary layer (depending on wind speed). From this boundary layer and depending on the current solution, Neumann conditions are formulated.

Based on the results from the previous steps, an experimental setup for the wind-channel is designed. The wind-channel experiments will be conducted while staying at the Colorado School of Mines.