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Using image based modelling to predict soil water dynamics

Keith Daly (1), Laura Cooper (2), Nico Koebernick (1), Arjen vanVeelen (1), Robbie Mayon (1), Dan McKay Fletcher (1), Callum Scotson (1), Simon Duncan (1), and Tiina Roose (1)

(1) University of Southampton, Southampton, United Kingdom (krd103@soton.ac.uk), (2) University of Warwick, Warwick, United Kingdom

The movement of water through soil is an inherently complex and multi-scale problem. Understanding how water moves on the pore-scale is essential for predicting plant water uptake, nutrient movement and soil stability. The detail that needs to be considered in predicting soil water dynamics depends on the scale of interest. On the pore-scale water dynamics are a complex function of pore geometry and chemistry. Moving to the plant scale water movement is often described using Richards' equation for partially saturated flow. In this presentation we discuss how mathematical upscaling techniques can be combined with structural information, obtained from X-ray Computed Tomography, to link these two scales.

Starting from a pore scale description of air and water movement we briefly show how Richards' equation can be derived and parameterised through a series of numerical simulations. In particular we show how the water release curve and the saturation dependent hydraulic conductivity of soils can be numerically estimated using this method. We apply the method to estimate the continuum hydraulic properties of different soil treatments and discuss how these properties could change in the presence of roots. Finally, we discuss the limitations of this method and how these models could be extended to include soil mechanical properties and rhizosphere effects such as compaction and root exudation.