Geophysical Research Abstracts
Vol. 20, EGU2018-19485, 2018
EGU General Assembly 2018

What lies beneath: Visualising the crucial interfaces in the undisturbed soil environment

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X-ray micro Computed Tomography (μCT) allows non-destructive visualisation and quantification of the undisturbed soil environment in three dimensions (3-D). This approach offers significant advances over destructive methods in terms of resolution, speed and the ability to observe the soil organo-mineral complex in a way not possible until relatively recently. This presentation will focus on the use of three crucial interfaces (seed:soil, root:soil and atmosphere:soil surface) where the use of μCT has demonstrated great promise in helping to demonstrate the role of the 3D porous architecture on soil function. The seed:soil interface is crucial for the early access and uptake of water and nutrients for a germinating seed. Whilst it is well recognised that a good contact with the soil is important for seeds, the precise geometric configuration of the structure around the seed for maximum development is unknown. We have recently shown that seed shape has an important impact on contact area and that improved germination is observed where total contact is >33%. The importance of the volume of soil surrounding roots i.e. the rhizosphere, is well established particularly in terms of the complex microbiological and chemical gradients that exist there. However the physical environment of the rhizosphere in terms of geometry of pore space in this region and how it varies in space and time and between soil and plant combinations has received little attention. Here we show that the structure that evolves at the immediate root interface is mediated by the soil texture, and that while the gross effect on soil structure of a penetrating root is a reduction in porosity, at the immediate root:soil interface the porosity can be enhanced due to the penetration mechanism of the root. The complexity of the soil structure at the soil surface and the connectivity of the pore network from the surface into the soil have a crucial impact on the hydraulic behaviour of a soil. This is heavily influenced by soil management, rainfall intensity and duration and the formation of biophysical crusts. We investigated the structure of the immediate surface at a resolution of a few microns and found crust formation was texture dependent and that biological crusts can have similar negative impacts on soil structure than physical crusts, though development times vary. Understanding the complex interactions and interfaces in soil is vital for future efforts to maximising inputs from the available land and for developing sustainable soil management strategies that are urgently needed.