Geophysical Research Abstracts
Vol. 18, EGU2016-11051, 2016
EGU General Assembly 2016

Soil hydraulic properties and REV study using X-ray microtomography and pore-scale modelling: saturated hydraulic conductivity

Kirill Gerke (1), Siarhei Khirevich (2), Timofey Sizonenko (3), Marina Karsanina (3,4), Aminat Umarova (5), Dmitry Korost (6), Stephan Matthai (1), and Dirk Mallants (7)

(1) The University of Melbourne, Department of Infrastructure Engineering, Australia (cheshik@yahoo.com), (2) PSE, KAUST, Thuwal, Saudi Arabia, (3) Schmidt's Institute of Earth Physics of RAS, Moscow, Russia, (4) Institute of Geosphere's Dynamics of RAS, Moscow, Russia, (5) Soil Science Faculty, Lomonosov Moscow State University, Moscow, Russia, (6) Geology Faculty, Lomonosov Moscow State University, Moscow, Russia, (7) CSIRO Land and Water, PB2 Glen Osmond SA 5064, Australia

To verify pore-scale modelling approach for determination of soil saturated hydraulic conductivity properties we scanned three cylindrical soil samples taken from A, Ah and B horizons using X-ray microtomography method. Resulting 3D soil images with resolutions of 15.25-20.96 μm were segmented into pores and solids and their maximum inscribed cube subvolumes were used as input data for three major pore-scale modelling methods to simulate saturated flow – lattice-Boltzmann method, finite-difference solution of the Stokes problem, and pore-network model. Provided that imaging resolution is high enough to capture the backbone of effective porosity and the main conducting pores all three methods resulted in simulated soil permeabilities close to experimental values for Ah and B samples. The resolution of A sample was not enough for an accurate modelling and we concluded that this soil requires multi-scale imaging to cover all relevant heterogeneities. We demonstrate that popular SWV method to choose segmentation threshold resulted in oversegmentation and order of magnitude higher permeability values. Careful manual thresholding combined with local segmentation algorithm provided much more accurate results. Detailed analysis of water retention curves showed that air-filled porosity at relevant pressure stages cannot be used for verification of the segmentation results. Representativity analysis by simulating flow in increasing soil volume up to 2.8 cm3 revealed no representative elementary volume (REV) within Ah sample and non-uniqueness of REV for B sample. The latter was explained by soil structure non-stationarity. We further speculate that structures soil horizons can exhibit no REV at all. We discuss numerous advantages of coupled imaging and pore-scale modelling approach and show how it can become a successor of the conventional soil coring method to parametrize large scale continuum models.