Geophysical Research Abstracts
Vol. 14, EGU2012-918, 2012
EGU General Assembly 2012


# Soil structure modeling with different correlation functions: current results and future perspectives

M. Karsanina (1), K. Gerke (1), R. Vasilyev (2), and E. Skvortsova (3)

(1) Institute of Geospheres Dynamics of Russian Academy of Science, Laboratory of Geomechanics and Fluidodynamics, Moscow, Russian Federation , (2) Vladimir State University, Department of Applied Physics and Mathematics, Vladimir, Russian Federation, (3) Dokuchaev Soil Science Institute of Russian Academy of Agricultural Sciences, Laboratory of Soil Physics, Moscow, Russian Federation

One of the main factors defining numerous flow phenomena in soils and other porous media, including fluid and solute movements, is pore structure, e.g., pore volume and its connectivity. In recent decades different numerical methods were developed to quantify single and multi-phase flow in such media on microscale. Among most popular ones are: 1) a wide range of finite difference/element/volume solutions of Navier-Stokes equations and its simplifications; 2) lattice-Boltzmann method; 3) pore-network models. Each method has some advantages and weak sides, so that different research teams usually utilize more than one, depending on the study case. Recent progress in X-ray tomography and some other techniques allows precise determination of soil three-dimensional structure, however, a trade-off between resolution and sample size is usually unavoidable. There are situations then only standard two-dimensional information of porous structure is known due to tomography high cost or resolution limitations. But physical modeling on microscale, there most interfacial processes take place requires 3D information.

There are three main approaches to reconstruct (using 2D cut(s) or some other limited information/properties) porous media: 1) statistical methods (correlation functions and simulated annealing, multi-point statistics, entropy methods), 2) sequential methods (sphere or other granular packs) and 3) morphological methods. Multi-point statistical method is believed to excel others due to its simplicity with respect to practical applications and better results (in particular pore space connectivity and anisotropy issues). Recently it was shown that cluster function implication significantly improve reconstruction quality, especially in comparison with original Yeong-Torquato technique based on two-point probability and linear functions. Another possible reason for these correlation functions poorer performance is computer power limitations of that time, e.g., high energy reconstructions (quality indicator in simulated annealing algorithm).

To investigate possibilities of different correlation functions we utilize high performance computing to reconstruct 3D soil structure from 2D cuts. As input data X-ray tomography slices are used. Obtained 3D structures are compared to original microtomography scans using conventional local porosity analysis, experimentally and numerically obtained single and multi-phase properties. It is clear that correlation functions have numerous advantages, including, for example, statistical information on soil structure that can be useful for classification and fast properties estimation, possibility to store and pass numerous soil texture data, statistically fuse structure information obtained on different scales. In addition to discussion of these issues, we provide some solutions on how to deal with soil anisotropy and non-stationarity. Finally, an insight into possible hybridization with other methods is given.