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Recent progress in the imaging of soil processes at the microscopic scale, and a look ahead

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Over the last few years, tremendous progress has been achieved in the visualization of soil structures at the microscopic scale. Computed tomography, based on synchrotron X-ray beams or table-top equipment, allows the visualization of pore geometry at micrometric resolution. Chemical and microbiological information obtainable in 2D cuts through soils can now be interpolated, with the support of CT-data, to produce 3-dimensional maps. In parallel with these analytical advances, significant progress has also been achieved in the computer simulation and visualization of a range of physical, chemical, and microbiological processes taking place in soil pores. In terms of water distribution and transport in soils, for example, the use of Lattice-Boltzmann models as well as models based on geometric primitives has been shown recently to reproduce very faithfully observations made with synchrotron X-ray tomography. Coupling of these models with fungal and bacterial growth models allows the description of a range of microbiologically-mediated processes of great importance at the moment, for example in terms of carbon sequestration. In this talk, we shall review progress achieved to date in this field, indicate where questions remain unanswered, and point out areas where further advances are expected in the next few years.