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Using super-resolution technique to elucidate the effects of imaging resolution on transport properties resulting from pore-scale modelling simulations

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Permeability is one of the fundamental properties of porous media and is required for large-scale Darcian fluid flow and mass transport models. Whilst permeability can be directly measured at a range of scales, there are increasing opportunities to evaluate permeability from pore-scale simulations. It is well known that single phase flow properties of digital rocks will depend on the resolution of the 3D pore image. Such studies are usually performed by coarsening X-ray microtomography scans. Recently we have proposed a novel approach to fuse multi-scale porous media images using stochastic reconstruction techniques based on directional correlation functions. Here we apply this slightly modified approach to create 3D pore images of different spatial resolution, i.e. stochastic super-resolution method. Contrary to coarsening techniques, this approach preserves porosity values and allows to incorporate fine scale data coming from such imaging techniques as SEM or FIB-SEM. We compute absolute permeability of the same porous media species under different resolutions using lattice-Boltzmann and finite difference methods to model Stokes flow in order to elucidate the effects of image resolution on resulting permeability values and compare stochastic super-resolution technique against conventional coarsening image processing technique.

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