EGU2020-1685
https://doi.org/10.5194/egusphere-egu2020-1685
EGU General Assembly 2020

Efficient Analytical Upscaling of Conductivity Tensor for Three-dimensional Heterogeneous Anisotropic Formations

Qinzhuo Liao, Gang Lei, and Shirish Patil
King Fahd University of Petroleum and Minerals, CPG, Petroleum Engineering, Saudi Arabia (liaoqz@gmail.com)

We propose an efficient analytical upscaling method to compute the equivalent conductivity tensor for elliptic equations in three-dimensional space. Our approach uses perturbation expansion and Fourier analysis, and considers heterogeneity, anisotropy and geometry of coarse gridblocks. Through low-order approximation, the derived analytical solution accurately approximates the central-difference numerical solution with periodic boundary conditions. Numerical tests are performed to demonstrate the capability and efficiency of this analytical approach in upscaling fluid flow in heterogeneous formations. We test the method in synthetic examples and benchmark cases with both Gaussian random fields and channelized non-Gaussian fields. In addition, we examine the impact of each parameter on the upscaled conductivity, and investigate the sensitivity of the variance and correlation lengths to the coefficients. We also indicate how to extend this approach to multiphase flow problems.