Three-stage multiscale algebraic preconditioner for highly heterogeneous diffusion subsurface problem on unstructured mesh

Davide Baroli

Departement of Mathematics, Laboratory for Modeling and Scientific Computing,
Politecnico di Milano,
Via Bonardi, 9,
Italy
davide.baroli@polimi.it
joint work with Luca Formaggia

In subsurface problem, diffusion flow with multiscale coefficients and nature of media properties pose significant challenges for numerical methods. We investigate a novel multiscale domain decomposition preconditioner for solving the Darcian flow characterized by highly heterogeneous and highly anisotropic permeability field. Among multiscale domain decomposition framework, we present a three-stage multiscale algebraic preconditioner that yield condition number bound independent of the contrast in the media properties, extending the recent two-scale additive Schwarz preconditioner based on spectral coarse space introduced by Efendiev. In this work the third stage of multiscale solver is provided by auxiliary coarse space based on variational subgrid correction, which is able to capture the high oscillatory energy modes inside and across the coarse-grid block. We also present different synthetic test cases of porous media problem with high degree of variability due to presence of barrier, inclusion, and salt triangular layers to validate the robustness of the multiscale solver proposed.