Sandve, Tor Harald, Berre Inga and Nordbotten, Jan Martin: An efficient multi-point flux approximation method for Discrete Fracture-Matrix simulation

Abstract: We consider a control volume discretization with a multi-point flux approximation to model Discrete Fracture-Matrix systems for anisotropic and fractured porous media in two and three spatial dimensions. Inspired by a recently introduced approach based on a two-point flux approximation, we explicitly account for the fractures by representing them as hybrid cells between the matrix cells. As well as simplifying the grid generation, our hybrid approach excludes small cells in the intersection of the fractures and hence avoids severe time-step restrictions associated with small cells. Excluding the small cells also reduces the condition number of the discretization matrix. For examples involving realistic anisotropy ratios in the permeability, numerical results show significant improvement compared to existing methods based on two-point flux approximations. We also investigate the hybrid method by studying the convergence rates for different apertures and fracture/matrix permeability ratios. Finally, the effect of removing the cells in the intersections of the fractures are studied. Together, these examples demonstrate the efficiency, flexibility and robustness of our new approach. JOURNAL OF COMPUTATIONAL PHYSICS, 231, (9), 3784-3800, MAY 1 2012.