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A multiscale flux basis for mortar mixed discretizations of Stokes-Darcy flows

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Abstract

A multiscale flux basis algorithm is developed for the Stokes-Darcy flow problem. The method is based on a non-overlapping domain decomposition algorithm, where the global problem is reduced to a coarse scale mortar interface problem that is solved by an iterative solver. Subdomain solves are required at each interface iteration, so the cost for the method without a multiscale basis can be high when the number of subdomains or the condition number of the interface problem is large. The proposed algorithm involves precomputing a multiscale flux basis, which consists of the flux (or velocity trace) response from each mortar degree of freedom. It is computed by each subdomain independently before the interface iteration begins. The subdomain solves required at each iteration are substituted by a linear combination of the multiscale basis. This may lead to a significant reduction in computational cost since the number of subdomain solves is fixed, depending only on the number of mortar degrees of freedom associated with a subdomain. Several numerical examples are carried out to demonstrate the efficiency of the multiscale flux basis implementation for large-scale Stokes-Darcy problems.

Keywords. Multiscale flux basis, mortar finite element, mixed finite element, Stokes-Darcy flow, non-overlapping domain decomposition, FETI method, balancing preconditioner

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