Adaptive Enriched Algebraic Multiscale Solver (AE-AMS)

H. Hajibeygi[1,a], A. Manea[2,b], H. A. Tchelepi[2,c]

[1]: Faculty of Civil Engineering and Geosciences, TU Delft, The Netherlands.
[2]: Department of Energy Resources Engineering, Stanford University, USA.
[a]: H.hajibeygi@tudelft.nl [b]: amanea@stanford.edu [c]: tchelepi@stanford.edu

Algebraic multiscale method (AMS) has been recently introduced to provide conservative and efficient solutions for elliptic and parabolic equations with heterogeneous coefficients. It was shown that the method was efficient for many practical three-dimensional test cases [Wang et al., JCP, 2014; Tene et al., ECMOR 2014]. However, in presence of high contrasts in the coefficients with long correlation length-scales, the method does not provide acceptable initial approximation (when no iteration is employed), neither does it perform as an efficient preconditioner. To resolve this limitation, in this work, we present an Adaptive Enriched Algebraic Multiscale Solver (AE-AMS) to improve both the multiscale solution and its multilevel preconditioning properties. Our enrichment strategy is developed following the recent work of Tene et al. [SPE RSS 2015] for fractured problems. Here, additional degrees of freedom at coarse level are introduced in the high contrast regions with long correlation length-scales. The additional and original AMS basis functions, combined, form partition of unity, and share adaptivity and local support. AE-AMS is efficient, because it minimizes the number of additional multiscale basis functions by accounting for both the underlying problem characteristics and the solver settings. Several challenging test cases are presented to illustrate its efficiency and applicability.