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A non-Overlapping Domain Decomposition Method to Solve Flow in Discontinuous Porous Media

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Abstract: In realistic hydrological or hydrogeochemical problems, the flow has to be solved in a domain presenting several superposed aquifers separated by layers with low permeability. More complex configurations, taking into account a fault and eventually a landslide along the fault, are also important in some applications as seismic research [1] or oil recovery [2]. In such configurations, each layer can be supposed a homogeneous porous medium and we have a piecewise constant permeability.
To solve the flow problem, a natural non overlapping domain decomposition is considered, taking into account the geological layers and the Dirichlet-Neuman algorithm of Schwarz type is used. However, it is known that this method is non always convergent, the distribution of Dirichlet and Neumann conditions being very important. A theoretical study of the convergence can be given in 1D case, but in 2D or 3D cases it becomes very difficult. On the other hand, the inter-changing of interface conditions being generally difficult to implement, the classical Dirichlet-Neumann algorithm seems not an appropriate decomposition method for such a problem. However, a simple idea can transform this non atractive algorithm in a powerful and simple tool to solve the flow problem: it is the using of its linearity property.
The method described in this communication is based by Aitken acceleration of the iterative solutions obtained by Dirichlet-Neuman algorithm and restricted to the interfaces. The idea of Aitken acceleration has been already used in [3] for the classical additive Schwarz algorithm. We place ourselves this study in the framework of finite elements method and for above configurations, we investigate how one can use the Aitken acceleration for the Dirichlet-Neuman algorithm. Some numerical experiments are presented and the obtained results are compared with the results obtained using other methods (as the method presented in [2] which uses some Robin conditions at the interfaces).

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[2] I. Faille, E. Flauraud, F. Nataf, F. Schneider, F. Willien, *Optimized interface conditions for sedimentary basin*, In N. Debit, M. Garbey, R. Hoppe, J. Príaux, D. Keyes, Y. Kuznetsov editors, Proc. Int. Conf. on Domain Decomposition Methods DD13, pages 461-468, DDM.org, 2001

[3] M. Garbey and D. Tromeur-Dervout, *On some Aitken acceleration of the Schwarz method*, Int. J. for Numerical Methods in Fluids, 40 (12) pages 1493-1513, 2002

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