

# A New Multiscale Simulation of Water Flows in Heterogeneous Porous Media

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## ABSTRACT

Actually, multiscale numerical methods that can take advantage of the recent resources and architectures of scientific programming are under active investigation [1]. This occurs because the high computational cost and the time expended solving high scale flow problems using fine grids.

The present work develops and applies a new numerical multiscale finite differences method (MsFDM) that can solve flux problems in heterogeneous porous media, modeled by an equation of Laplace or Poisson, in several spatial scales.

For such, it is used an iterative procedure of overlapping domain decomposition and the creation of multiscale bases functions to capture all the fine grid heterogeneous permeability information. In order to create the function bases, the local problem on each subdomain is resolved considering normalized Dirichlet boundary conditions and discretizing the subdomain using finite differences, resulting in a system of linear equations solved by the preconditioned conjugated gradient method. Then, the local solution is obtained through function bases linear combinations.

Lately, the global domain solution is gotten through an iterative procedure of information exchange among subdomains, what makes of it a parallelizable method for architectures of several CPUs and/or GPUs. In order to show the method's efficiency and accuracy, several numerical experiments were performed simulating the flow of underground water in high randomness permeability fields. The results obtained with the MsFDM are in agreement with the global solutions in fine grid with the computational cost of the finite elements and finite differences traditional methods. We conclude that the MsFDM is promising considering its use in parallel programming.

## REFERENCES

- [1] A. S. Francisco, A. S., V. Ginting, F. Pereira, and J. Rigelo, Design and implementation of a multiscale mixed method based on a nonoverlapping domain decomposition procedure, *Mathematics and Computers in Simulation*, Vol. 99, pp. 125-138, (2014).