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COUPLING FREE FLOW AND POROUS-MEDIUM FLOW: COMPARISON OF NON-REFINED, GLOBALLY-REFINED AND LOCALLY-REFINED AXIPARALLEL FREE-FLOW GRIDS

Wednesday, 2 June 2021 10:00 (1 hour)

In a variety of technical, medical and environmental applications, free flow coupled to porous-medium flow plays a crucial role. Due to the strong mutual interaction of the flow in both regimes, complex flow fields develop in the free-flow regime [1]. This holds especially true in the case of rough porous-medium-free-flow interfaces or when pores of a pore-network [2] touch the freeflow. Those complex flow patterns contain regions which have to be resolved in more detail than others. To resolve them, we can use overall, global or local refinement.

We use a finite-volume staggered-grid discretization, to avoid spurious pressure oscillations and to obtain local conservation. In this context we compare the overall and global refinement of axiparallel grids to a quadtree local refinement method [3].

We implemented those free-flow discretizations in our open-source simulator Dumux [4], along with a monolithical coupling to the porous medium. We present a comparison of the three refinement strategies for various test cases. Furthermore, we discuss that distorted stencils, interpolations and local truncation errors contribute to the results we get.

Time Block Preference

Time Block A (09:00-12:00 CET)

References

[1] Coltman, E., Lipp, M., Vescovini, A., & Helmig, R. (2020). Obstacles, Interfacial Forms, and Turbulence: A Numerical Analysis of Soil-Water Evaporation Across Different Interfaces. Transport in Porous Media, 134(2), 275–301. https://doi.org/10.1007/s11242-020-01445-6

[2] Weishaupt, K., Terzis, A., Zarikos, I., Yang, G., Flemisch, B., de Winter, D. A. M., & Helmig, R. (2020). A Hybrid-Dimensional Coupled Pore-Network/Free-Flow Model Including Pore-Scale Slip and Its Application to a Micromodel Experiment. Transport in Porous Media, 135(1), 243–270. https://doi.org/10.1007/s11242-020-01477-y

[3] Lipp, M., & Helmig, R. (2020). A Locally-Refined Locally-Conservative Quadtree Finite-Volume Staggered-Grid Scheme. In G. Lamanna, S. Tonini, G. E. Cossali, & B. Weigand (Eds.), Droplet Interactions and Spray Processes (Vol. 121, pp. 149–159). Springer. https://doi.org/10.1007/978-3-030-33338-6

[4] Koch, T., Gläser, D., Weishaupt, K., Ackermann, S., Beck, M., Becker, B., Burbulla, S., Class, H., Coltman, E., Emmert, S., Fetzer, T., Grüninger, C., Heck, K., Hommel, J., Kurz, T., Lipp, M., Mohammadi, F., Scherrer, S., Schneider, M., Seitz, G., Stadler, L., Utz, M., Weinhardt, F., Flemisch, B. (2020). DuMux 3 –an open-source simulator for solving flow and transport problems in porous media with a focus on model coupling. Computers & Mathematics with Applications. https://doi.org/10.1016/j.camwa.2020.02.012

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Primary author: LIPP, Melanie

Co-authors: SCHNEIDER, Martin (University of Stuttgart); WEISHAUPT, Kilian (University of Stuttgart); HELMIG, Rainer (University of Stuttgart)

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