

Multi-physics and multi-domain simulation of coupled processes in geo-environmental systems

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Abstract

The simulation of multiple coupled physical processes in geo-systems, such as fluid flow, poromechanics, ground rupture generation, thermal flow, and chemical reactions, that can take place simultaneously with multiple time and space scales, plays a crucial role for a proper management of surface and subsurface environments in a changing planet. To this aim, the availability of effective computational tools is a fundamental element to allow for robust, accurate, and reliable predictions. We focus on the development of GReS (Geomechanical Reservoir Simulator), a novel open-source modular platform specifically designed with the aim at contributing to the design and testing of numerical algorithms for fully coupled multi-physics multi-domain poromechanical applications. The idea is to partition the overall computational domain into possibly non-conforming subdomains, joined by a novel implementation of the mortar method [1], where different physics and discretization schemes can be used. The code is based on a high-level programming platform (MATLAB) and a fully open-source policy, in order to lower the entry barrier for new users and developers, as well as the effort for implementing and testing innovative numerical algorithms. In the present communication, we will introduce the GReS concept and its current development state. In particular, we focus on recent algorithmic advances on the stable simulation of multiple-scale fractures in a porous medium by combining their explicit and implicit representation in non-conforming discretizations [2]. Applications will be presented, dealing with the management (storage and withdrawal) of underground resources and the long-term evolution of transition environments, such as coastal areas and lagoons, in a changing climate.

Keywords: multi-physics, multi-domain, porous media, open-source software

References

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