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Modelling CO_2 flow in naturally fractured geological media using MINC and multiple subregion upscaling procedure

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Geological storage of CO_2 represents one viable solution to reduce greenhouse gas emission in the atmosphere. Potential leakage of CO_2 storage can occur through networks of interconnected fractures. The geometrical complexity of these networks is often very high involving fractures occurring at various scales and having hierarchical structures. Such multiphase flow systems are usually hard to solve with a discrete fracture modelling (DFM) approach. Therefore, continuum fracture models assuming average properties are usually preferred.
The multiple interacting continua (MINC) model is an extension of the classic double porosity model (Warren and Root, 1963) which accounts for the non-linear behaviour of the matrix-fracture interactions. For CO_2 storage applications the transient representation of the inter-porosity two phase flow plays an important role.
This study tests the accuracy and computational efficiency of the MINC method complemented with the multiple sub-region (MSR) upscaling procedure versus the DFM. The two phase flow MINC simulator is implemented in the free-open source numerical toolbox DuMux (www.dumux.org). The MSR (Gong et al., 2009) determines the inter-porosity terms by solving simplified local single-phase flow problems. The DFM is considered as the reference solution. The numerical examples consider a quasi-1D reservoir with a quadratic fracture system , a five-spot radial symmetric reservoir, and a completely random generated fracture system.

Keywords: MINC, upscaling, two-phase flow, fractured porous media, discrete fracture model, continuum fracture model