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Parallel numerical modeling of two-phase flow during CO_2 storage in saline aquifers

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Numerical modeling of CO_2 storage processes in saline aquifers is computationally expensive due to the complexity and nonlinearity of the observed physical processes (e.g., two-phase flow) , and the large size of real reservoir site that also exhibits a heterogeneous distribution of material properties. The modeling of the physical process in the storage sites with a high degree of accuracy requires a fine discretization of the considered domain. Naturally, this leads to the requirement of extremely high computational resources.

This work focuses on the parallel simulation of the two-phase flow in CO_2 storage sites. The Galerkin finite element method is used to solve the governing equations. Based on the overlapped domain decomposition approach, the PETSc package is employed to parallelize the global equation assembly and the linear solver, respectively. A numerical model based on the real test site Ketzin in Germany is adopted for parallel modeling. The model domain is discretized with more than four million tetrahedral elements. The parallel simulations are carried out on super computers with different number of cores. The obtained speedup shows a good scalability of the current parallel finite element approach of the two-phase flow modeling in geological CO_2 storage applications.