quasi-steady state trend. Pressure buildup development in the medium, in particular the transient pressure changes, can be influenced dramatically by geological heterogeneities. This study aims to evaluate the importance of sophisticated geological modeling in simulating the pressure variation in the domain.

Spatial pressure distribution in the aquifer depends on the extent of the domain. The available volume for CO_2 storage in closed or semi-closed systems with limited spatial extent is mostly provided by medium compressibility in response to formation pressure buildup. Moreover, the caprock and structural traps that are supposed to be sealing may allow the CO_2 to leak at a rate that depends on the pressure buildup in the aquifer. Birkholzer et al. [3] investigated the influence of domain size on pressure rise in the medium caused by CO_2 injection, assuming a homogeneous aquifer to study the pressure development for various model sizes, ranging from 10 to 100 km. They simulated CO_2 injection over 30 years in 250 m thick formation with a rate of 120 kg/s, and performed sensitivity analysis with focus on the plume migration and the evolution of pressure buildup in the aquifer. In addition to the spatial extent, various hydrological properties were examined to study the impact on CO_2 storage capacity. The results in [3] suggest that the storage capacity in closed and semi-closed aquifers is controlled by the operational pressure constraints and it is much smaller than the capacity of large aquifers. The simulations in [3] show that the region of elevated pressure is much larger than the size of the CO_2 plume. In a 20 km model, a substantial pressure increase of 45 bar from hydrostatic was observed at the model boundaries. They used closed boundary condition in the model that caused a global pressurizing in the medium. A local pressure rise above 60 bar was simulated near the injection well.

In general, constraints must be imposed on the bottom-hole pressure of the injection well to limit the pressure buildup in the aquifer, which will typically reduce the injection rate that is possible to safely achieve. Rock quality within the injection region has a significant impact on pressure buildup and therefore geological uncertainty plays a considerable role in assessing the success and feasibility of the operation. Most of the pressure-related studies in the literature provide either deterministic case studies or generic preventive measures based on theoretical studies [12, 17, 8, 18, 14, 13]. It is important to include realistic geological descriptions in any geological uncertainty study. For example, realistic permeability variation in the grid should be included, possibly in the form of an ensemble of equiprobable realizations.

Within the context of oil recovery, the impact of geological uncertainty on different field-development strategies is thoroughly investigated in the SAIGUP project for shallow-marine depositional systems [7, 9, 10]. Based on several injection/production patterns, the study concludes that geological uncertainty has a dramatic influence on the oil recovery estimates. We have previously used a number of geological realizations from the SAIGUP project to investigate the impact of geological uncertainty on the injection and early migration of CO_2 [2, 1]. The focus in these studies was to use the parametrized ensemble of geological realizations to measure how sensitive the spatial CO_2 distribution is to variations in the geology. Certain structural features were considered and several flow responses were defined to measure the storage capacity, the trapping efficiency, and the leakage risk. The sensitivity of these responses to variations in geological parameters was investigated. The results show that varying the geology gives large variation in responses, and aggradation angle and barrier coverage were found to have the most significant impact on the CO_2 flow behavior [2, 1].