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## Abstract

Geological CO<sub>2</sub> sequestration is one of the main enablers for reducing carbon emissions. Prediction of CO<sub>2</sub> behavior in uncertain subterranean formations requires more robust descriptions of the most critical geological and multiphase parameters. The objective of this work is to present a sensitivity analysis of multiphase parameters on the amount of CO<sub>2</sub> stored/leaked in a sequestration project and to identify the most critical parameters that we need to focus on to ensure successful project implementation.

A vertical equilibrium model is used to simulate the sequestration process for over 1000 years in the Johansen formation, which is a candidate site for large-scale CO<sub>2</sub> storage offshore the southwest coast of Norway. The multiphase parameters of the capillary pressure and the relative permeability curves are altered randomly (Monte Carlo experiment). A distance-based generalized sensitivity analysis (DGSA) is used to interpret the responses and quantify the most influential parameters on five different masses of CO<sub>2</sub> (free plume, leaked, residual after water reimbibition, residual CO<sub>2</sub>, trapped residually in structural traps).

Amongst the five different masses of CO<sub>2</sub> investigated in this work, the most influencing parameters were the residual CO<sub>2</sub> saturation and the relative permeability exponent. The residual water saturation, capillary pressure curve exponent, and the entry pressure had much lesser effect on the computed masses of CO<sub>2</sub>. The mass of CO<sub>2</sub> in the free plume as well as the mass of residual CO<sub>2</sub> in the plume after water reimbibition were most sensitive to the residual CO<sub>2</sub> saturation. On the other hand, the mass of CO<sub>2</sub> leaked from the aquifer, the mass of residual CO<sub>2</sub>, and the mass of CO<sub>2</sub> that is trapped residually in the structural traps were most sensitive to the relative permeability exponent.

The results of our work indicate that initial experimental investigation in a sequestration project should be directed towards limiting the uncertainty of the relative permeability parameters such as the residual CO<sub>2</sub> saturation and the relative permeability exponent.