A parallel scheme for accelerating optimization of well placement for geologic CO2 storage

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Carbon dioxides Capture and Storage (CCS) is a viable technique for reducing the amount of CO_2 emitted to the atmosphere by injecting captured CO2 into reservoirs underground. When we consider commercial-scale CCS with more than 1Mt/y injection rate, the placement strategy of multiple injection wells is significant to sequestrate required volume of CO_2 in the reservoir. In addition, pressure relief well might be effective to mitigate build-up pressure in the reservoir due to the large volume injection. These well locations should be determined effectively because it affects allowable volume of CO2 injection and project cost. However, selecting optimum solution from a huge number of simulations by manually changing well locations is not realistic. Therefore, automatic and efficient optimization methods that can reduce number of reservoir simulations and obtain beneficial solution will be essential.

In this study, we developed a new tool by combining an optimization algorithm, Covariance Matrix Adaptation Evolution strategy (CMA-ES), with a parallel reservoir simulator TOUGH2-MP. However, a few thousands of the reservoir simulations for solution candidates are usually needed to obtain an optimum solution. Thus it is often difficult to find an optimum solution within realistic time. Therefore, we implemented our optimization tool on a supercomputer (Oakforest-PACS) for reducing the computational time of optimization by running reservoir simulations for many solution candidates concurrently utilizing thousands of CPU cores in parallel. The performance of the tool was investigated and demonstrated through an optimization problem of placement of multiple wells for injection and pressure-relief on a hypothetical reservoir model with heterogeneous properties.

Keywords: Carbon dioxides Capture and Storage, Well placement, Covariance Matrix Adaptation Evolution Strategy, Oakforest-PACS

