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# Models for large-scale Simulation of $CO_2$-Storage in geological Formations

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Carbon dioxide Capture and Storage (CCS) is a technology that is currently developed for mitigating global greenhouse gas emissions while fossil fuel combustion still is a main pillar for energy production in the next couple of decades.

$CO_2$ is captured from large fossil-fuelled (mostly coal) power plants, then transported to a storage site, and eventually injected into a deep geological formation.

Modelling $CO_2$ storage in saline aquifers on a reservoir scale is demanding with respect to the complexity of the non-linear processes occurring on different spatial and tempora scales as well as with respect to computational costs. Large and complex geometries need to be described for a realistic scenario. The models need to be able to describe non-isothermal, multiphase and compositional processes that occur during $CO_2$ storage.

In most cases, it is not necessary to describe all the physical processes for the entire simulation time period. Especially for $CO_2$ storage the dominating processes vary over time.

During and shortly after the injection, the plume evolution in the formation is dominated by advective multiphase processes driven by viscous and buoyant forces. Moreover, the non-isothermal behaviour in the vicinity of the expanding plume due to the Joule Thompson effect needs to be described. With increasing time scale, the dissolution of $CO_2$ into the brine, compositional effects, diffusion and density-driven brine-convection become more and more important and cannot be neglected when modelling over large time periods.

Considering this time-dependent behaviour, it is possible to describe a certain time scale with models of reduced/adapted complexity. For the simulation of the short-term behaviour a non-isothermal two-phase model can be applied whereas the long-term behaviour can be described with a two-phase two-component model, neglecting non-isothermal effects. By coupling these models of reduced complexity, the model efficiency is increased without neglecting the relevant phenomena.