Data-driven optimisation algorithms for local dynamic model adaptivity

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Since underground storage of hydrogen in aquifers, as depicted in Fig. 1, becomes a promising option for energy storage, reliable and efficient models for simulating fluid migration in the subsurface are desired. To this end, we couple a dimensionally-reduced Darcy model, the so-called Vertical Equilbrium (VE) model as introduced by [3], with a full dimensional Darcy model. While the full dimensional model provides accuracy, the VE model provides smaller computational times. However, the VE model relies on the assumption of instant gravity segregation und thus should only be used at locations where the error resulting from this assumption is not too significant. Therefore, we utilize a local criterion which indicates which model can be used locally to find a good balance between accuracy and efficiency. Moreover, given simulation data we learn certain functions of the VE model using linear regression, in order to obtain analytical formulations and thus reduce the computational time of the VE simulation even further. Specifically, instead of solving a local non-linear equation for computing the height of the gas plume in the domain, we utilize a learned analytical function. We also compare the efficiency of the adaptive coupling scheme using an IMPES solver as described by [1] and [2] with the efficiency of solving the scheme in a fully implicit manner. That is because non-linearities, e.g. the impact of the capillary pressure on the flow field in porous media, require the explicit schemes to use inefficiently small time steps in order to resolve the non-linearities.

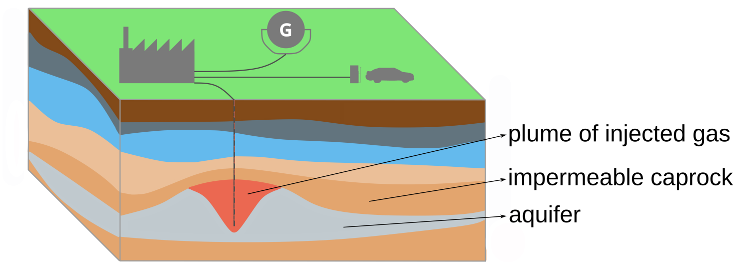

Figure 1: Illustration of the underground gas storage system.

References

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