A Decoupled Model for Compositional Multiphase Flow in Porous Media and Multiphysics Approaches for Two-Phase Flow*

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Abstract

In many practical applications of porous media flow simulators, the most complex processes are confined to a small part of the model domain. The demands of a simulator on computational resources increase with the physical complexity of the model. Thus, a trade off between physical accuracy and the computational demands of a model has to be made. Either great complexities are neglected in favor of a lean model or all processes are captured with a complex model, which is superfluous in large parts of the domain. As a compromise between these options, a consistent transfer concept is introduced (Figure 1). It couples simple and complex models and adapts the resulting multiscale model to the physical processes actually occurring. As a basis for this, a decoupled formulation for non-isothermal compositional multiphase flow will be discussed. It has the advantage that the size of the linear system of equations does not grow with the number of phases or components involved.

Discussion

One part of the presentation reviews common concepts for the description of multiphase flow in porous media and provides a consistent derivation of the conservation equations of non-isothermal compositional flow and transport processes. Based on these equations, decoupled formulations for isothermal and non-isothermal compositional flow are derived, using the concept of the local conservation of total fluid volume. The implementation of the derived formulations into a finite volume method with an implicit pressure, explicit concentration time discretization will be presented. The resulting simulation tool is tested and verified with results from various experimental and computational investigations and its range of applicability is considered.

Conclusion

Based on the decoupled formulations derived before, an isothermal and a non-isothermal multiphysics concept for the transition of complexity within a porous media domain will be presented. Furthermore, a simple and robust subdomain control scheme is developed which ensures optimal adaption of the model complexity to the occurring processes at any time (Figure 2). Both models are implemented and tested towards their accordance with the globally complex decoupled models. It will be shown that the computational demands of a simulator can be decreased by incorporating the multiphysics schemes. Finally, further ideas for the extension of the multiphysics towards more complex systems and possible interfaces with multiscale methods will be discussed.

References

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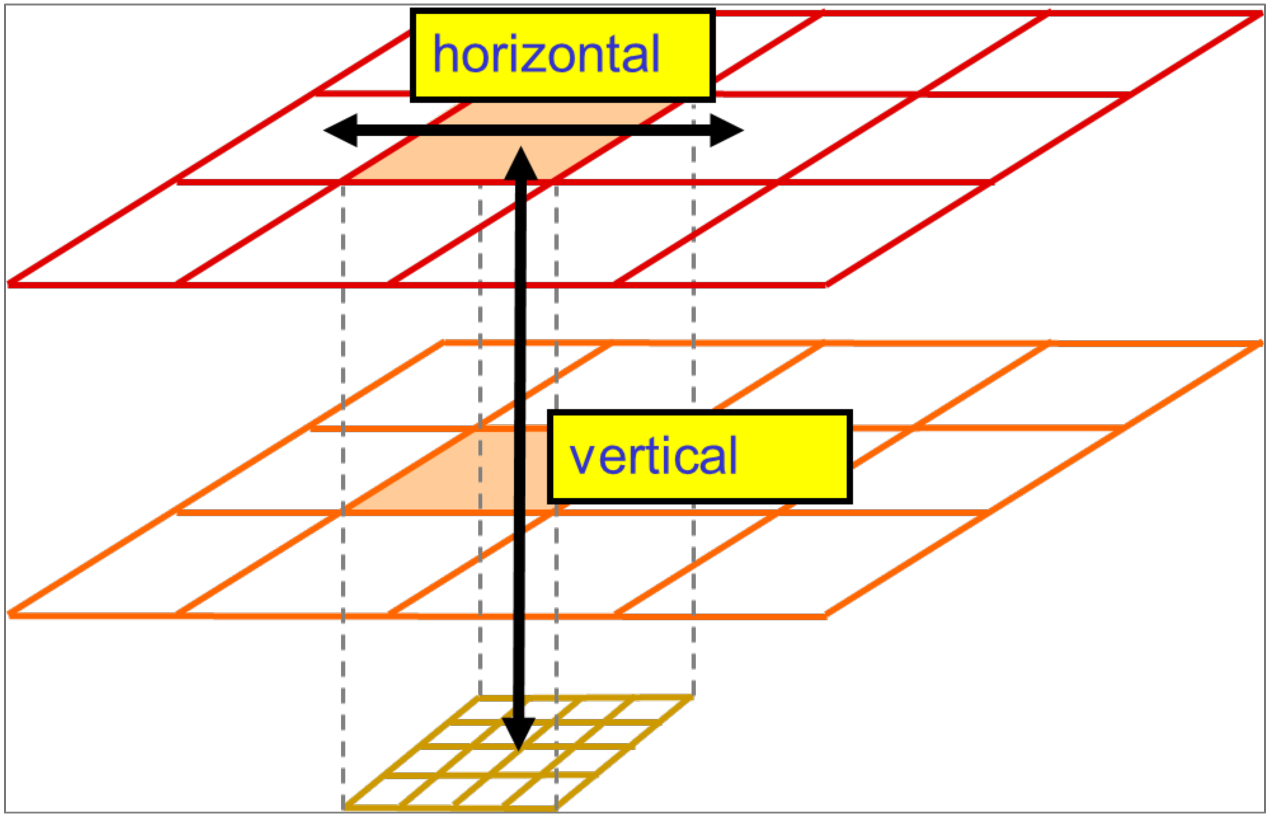

Figure 1: Multiphysics coupling strategy.

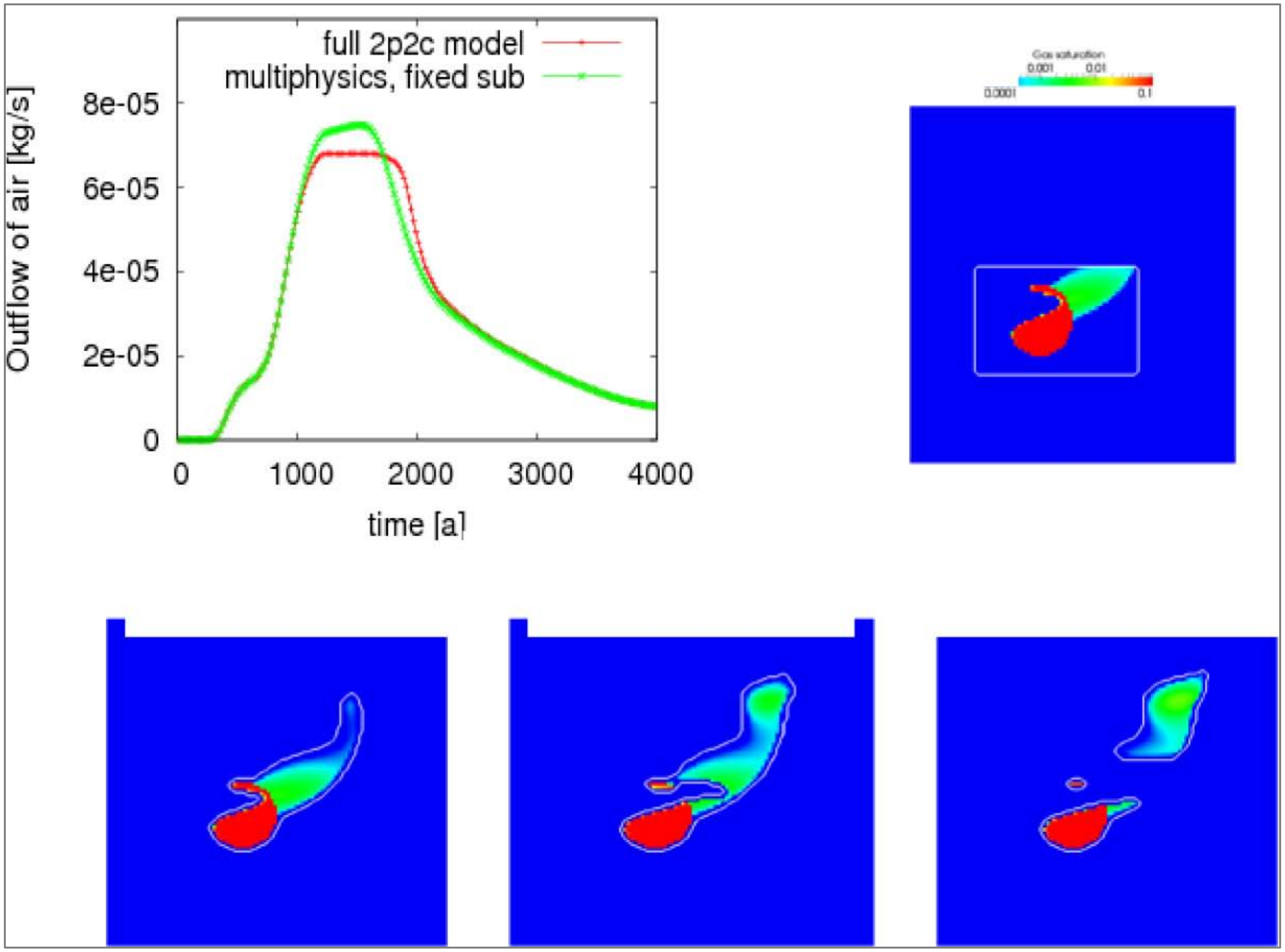

Figure 2: Comparison study: full 2p2c model and multiphysics 2p2c model.