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# A Knowledge-Driven Reduced-Order Model with a data-driven corrector for thin porous media

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Thin, porous media are ubiquitous in several environmental, industrial and engineering fields. Examples of such media are soil, aquifers, filters, fuel cells, in addition to some biological tissues such as cartilage. The dynamical behavior of such media is typically described and predicted using mathematical models in the form of coupled, nonlinear, partial differential equations (PDEs). Discretization of these PDEs leads to high-fidelity models requiring advanced numerical methods to provide simulations of high accuracy. Despite the huge advances in computational algorithms and computer chips, simulations might still be time-consuming. This can be problematic for many applications, such as design optimization, model-based predictive control, or clinical-time constraints.

For thin, porous media, the property of scale separation is naturally satisfied such that fluid's pressure is almost hydro-static in the small-scale direction. This property has been utilized to construct knowledge-driven reduced-order models using methodologies such as vertical averaging [1], asymptotic analysis [2,3], or rigid convergence analysis [4]. The resulting reduced model is typically a set of 1D equations describing the leading dynamics, mainly, in the large-scale direction. It has reduced computational complexity and provides proper approximations of the high-fidelity solutions. However, thin porous materials might violate the assumption of hydro-static pressure, e.g., due to high permeability gradients in the small-scale direction. For such cases, correctors must be considered to recapture the less effective dynamics. In [3], a knowledge-driven corrector is derived via asymptotic analysis for the higher-order terms in the asymptotic expansions. This corrector slightly improves the accuracy as it partially depends on the hydro-static assumption. Thus, we propose a novel data-driven corrector using projection-based methods, such as the method of proper orthogonal decomposition. For this, we use a training data-set of the errors induced by the reduced model at those configurations violating the assumption of hydro-static pressure. Numerical examples to validate the method are also performed.

## Participation

In-Person

## References

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[2] Armiti-Juber, A., and Rohde, C. (2019): Computational Geosciences.
[3] Armiti-Juber, A. and Ricken, T. (2022): Archive of Applied Mechanics.
[4] Armiti-Juber, A. (2022): Mathematical Methods in the Applied Sciences.

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