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MODEL ORDER REDUCTION FOR MULTISCALE PROBLEMS IN GEO-ENGINEERING

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ABSTRACT

Many multiscale evolutionary models in science and engineering are governed by non-linear partial differential equations. Several aspects need to be taken into account when solving these equations numerically, such as: *(i)* efficiently capturing the relevant phenomena over the various spatio-temporal scales and *(ii)* solving at a good level of accuracy within a reasonable computing time. Developing reliable numerical techniques is an essential step in combined fluid-solid mechanics problems from geo-engineering applications, applications such as for instance drilling.

Several scientific challenges pertaining to robust and efficient numerical techniques are addressed in this mini-symposium, among which:

- capturing multiple length and time scales with robust and accurate spatial/temporal discretization techniques guaranteeing non-linear stability;
- dealing with sharp gradients and moving discontinuities, under the imposition of smooth/non-smooth initial-boundary conditions;
- preventing smearing and spurious oscillations near sharp gradients;
- efficiently addressing the distributed non-linearities and delays due to wave propagation;
- handling problems with strong dependence on initial-boundary conditions, geometrical configurations and input/control parameters;
- preserving physical properties, such as positivity and monotonicity, in the numerical discretization of the partial differential equations;
- exploiting model order reduction (MOR) techniques (such as proper orthogonal decomposition, reduced basis, balanced truncation and empirical interpolation) in order to drastically reduce computational times without compromising solution accuracy [1,2].

In the mini-symposium, new ideas are presented on the numerics and benchmarking of high-fidelity discretization methods (among which finite-volume, finite-element and discontinuous Galerkin methods). Further, innovative trends in MOR are presented to assist real-time decision making, which is a necessity in industrial applications. The aim is to support the development of new and advanced numerical approaches in the context of parameterized analysis, many query simulations and reliable results. The combination of high predictive capacity and low complexity is crucial for enabling the use of virtual scenario testing, estimator and controller designs, and optimization of operations involved in real scenarios.

This mini-symposium brings together researchers and industrial experts from fluid dynamics, structural mechanics, model order reduction and numerical mathematics, to exchange research ideas and methodologies, to encourage cooperation and to bridge the gap between academia and industry.

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