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Use of Physics-Based Machine Learning Surrogate Models for Optimal Sensor Placement

The forcing exerted over subsurface reservoir during operations to extract geothermal heat causes changes in, for instance, the subsurface pressure and temperature state, which can lead to induced seismicity. Therefore, an appropriate consideration of the expected measurable response of the reservoir is needed to design reliable monitoring systems. Computer assisted simulations of thermo-hydraulic-mechanical (THM) processes in fractured reservoirs allow to get a prognosis of the reservoir state and its evolution during operations and to consequently get the expected seismic event number and ground motion amplitudes as design monitoring criteria. The caveat is that an optimal strategy requires a large number of simulations to testing possible monitoring configurations, which makes the usage of full order models unfeasible because of the high associated computational cost. To bypass this barrier, we explore the use of physics-based machine learning surrogate models using the non-intrusive reduced basis method, to obtain fast and accurate solutions. We showcase this methodology for the construction of reliable surrogate models for a reservoir in the transition between convection and conduction dominated heat transfer, which is representative for a wide range of common conditions encountered in geological reservoirs. We especially highlight the differences, to entirely data-driven approaches. We finally illustrate the integration process into algorithms for optimal sensor placements, and how application specific-constraints can be considered.

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