A GLOBAL SAMPLING-BASED METHOD FOR INTEGRATING PHYSICS-SPECIFIC SUBSYSTEMS AND ASSESSING UNCERTAINTY PROPAGATION OF CO2 GEOLOGICAL SEQUESTRATION

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Risk of CO2 leakage from a deep storage reservoir into a shallow aquifer through a fault is assessed using physics-based simulations. A hypothetical CO2 geological sequestration system is composed of three subsystems: a deep storage reservoir, a fault through cap rock, and a shallow aquifer. Each subsystem can be modeled by considering sub-domain-specific physics. Supercritical CO2 is injected to the saline reservoir subsystem with uncertain permeability and uncertain spatial correlations at an uncertain location and injection rate (as decision variables). T he simulated pressure and CO2/brine saturation are connected to the fault leakage model as a boundary condition. CO2 and brine fluxes from the fault leakage model at the fault outlet are then imposed in the groundwater model as a source term. Uncertainties are propagated from the deep reservoir model, to the fault model, and eventually to the geochemical model in the shallow aquifer, therefore affecting the risk profiles. To quantify the uncertainty propagation and assess leakage-relevant risks, we implement a global sampling-based method to allocate sub-dimensions of uncertain parameters to sub-models. The risk profile is defined and related to CO2 plume propagation and pH values below the MCL (Maximum Contaminant Level). A global sensitivity analysis is conducted to select the most sensitive parameters to the risk profile. Subsequently, a high-resolution reduced-order model of the risk profile is developed which accounts for all decision variables and uncertain parameters in all three sub-models.