**Dynamic simulation for gas injection**

**Scientific Problem:** Within carbon storage, the spatial distribution of the subsurface reservoir and its internal architecture, such as irregularly distributed baffle zones and stratification, can affect preferential CO₂ migration pathways. Thus the effect of subsurface geological features must be carefully analysed. This is a challenging aspect of numerical simulation, which requires irregular grids to capture the architecture. Currently few injection simulations account for differential grid geometries.

**Methods:** A new approach is proposed for simulation runs with varied grid geometries, comprising of both different stratifications and baffle zones. The modelling approach proposed by this study can be used for simulations at different scales and specifically for permeability upscaling of strongly heterogeneous reservoirs.

**SIMPLE ARCHITECTURES**

A standard simulation model based on Darcy’s equation: If two adjacent sites have equal pressure, Darcy’s equation will predict no flow across their common boundary.

**COMPLEX ARCHITECTURES**

A 2D model developed in GEM, a compositional simulator in CMG®建, with two grid sizes in x-direction: 10 m and 1 m, respectively. The baffle zone is 1 km in length and 1 m in height.

**CHIP FIRING INJECTION MODEL**

A reservoir is modeled as a grid of cells or sites capable of storing CO₂. Movement of CO₂ is possible between sites that are connected by edges (representing, e.g., fractures, etc.). The CO₂ is simulated as discrete packets, with movement governed by threshold dispersion (through chip firing) and dispersion effects from depth dependent pressure gradients. A critical site value Ccrit is assigned to each site. If a site accumulates more than Ccrit packets of CO₂, some number of packets are dispersed to (edge) connected sites.

In the case of chip firing, if the same number of chips are present at two adjacent sites, either they are both below Ccrit and no flow occurs, or they swap an equal number of packets, this is equivalent to no flow occurring. Variables that are fixed across all the architectures are:

- Number of rows R = 30.
- Number of columns C = 120.
- Baffle length B = 60 (running from column 30 to 90).
- Baffle width W = 2 (from row 10 to 12).
- Critical site value Ccrit = 5 times the edges connected to the site.

Exceptions for a square grid are:

- Ccrit = 2 times the edges to test ‘easy transmission’
- Ccrit = 20 times the edges to test ‘inhibited transmission’

**Advantages:**

- Time efficiency
- High flexibility architecture
- Useful for upscaling

**FUTURE GOALS:**

The potential is for fast and efficient mechanisms to capture the effect of differing internal strata architecture on single phase and multi-phase flow regimes. Graph theory is used to encapsulate the different architectures and chip firing captures the horizontal movement and upward motion with a depth component to simulate the flow regime of real world reaction/diffusion systems. Future plans include incorporating additional physical properties for the study of more complex architectures on which to trial this modeling technique.

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