



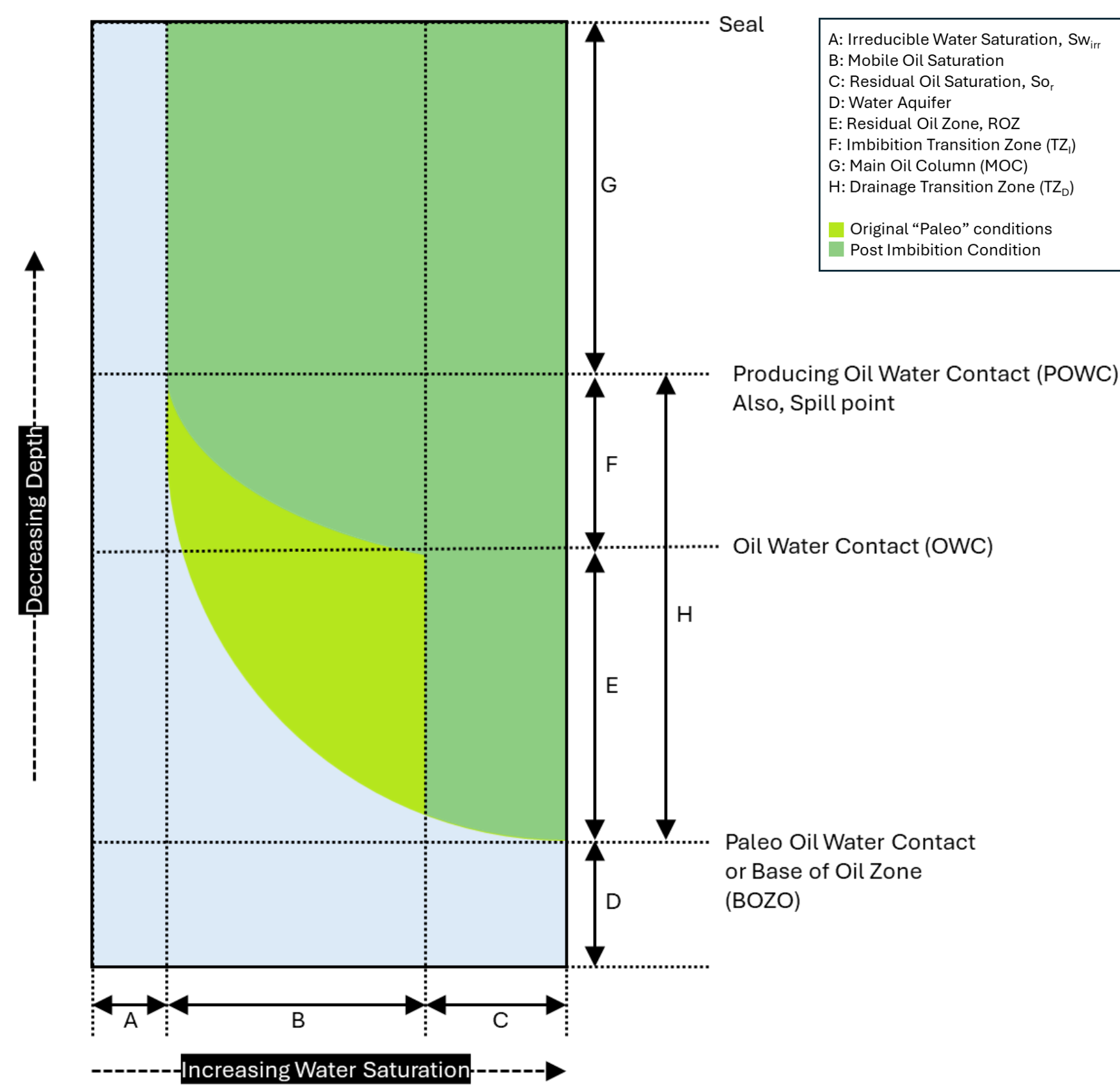
Improving Simulation Accuracy of CO₂ Storage in Residual Oil Zones and Depleted Hydrocarbon Reservoirs

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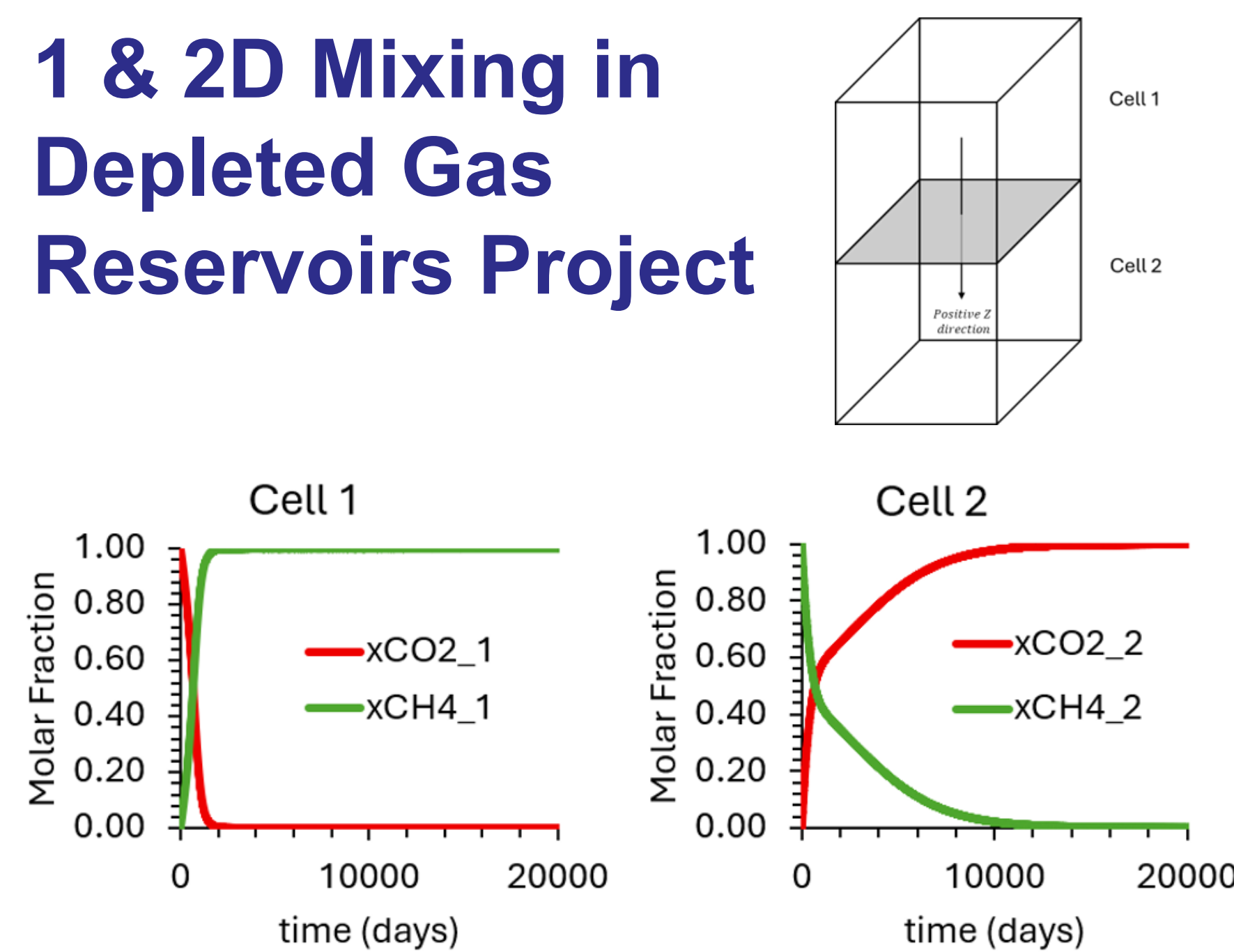
BACKGROUND

ROZ Initialization Project



Saturation Profile pre and post imbibition

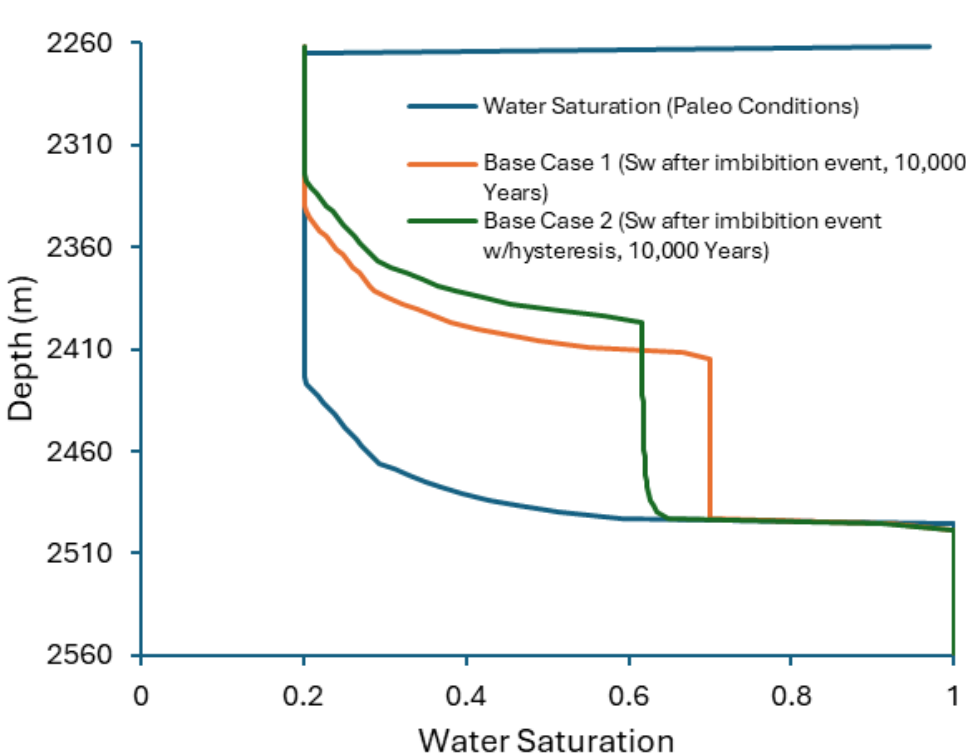
1 & 2D Mixing in Depleted Gas Reservoirs Project



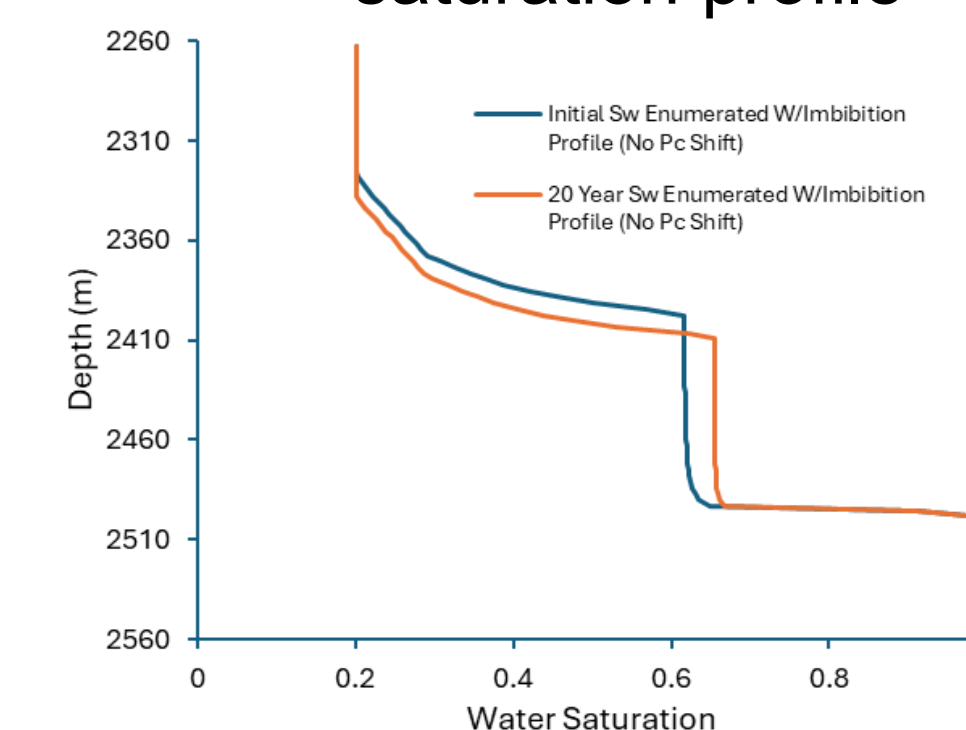
CO₂ and CH₄ Mole% in a 2 Cell Conceptual Model

METHODOLOGY

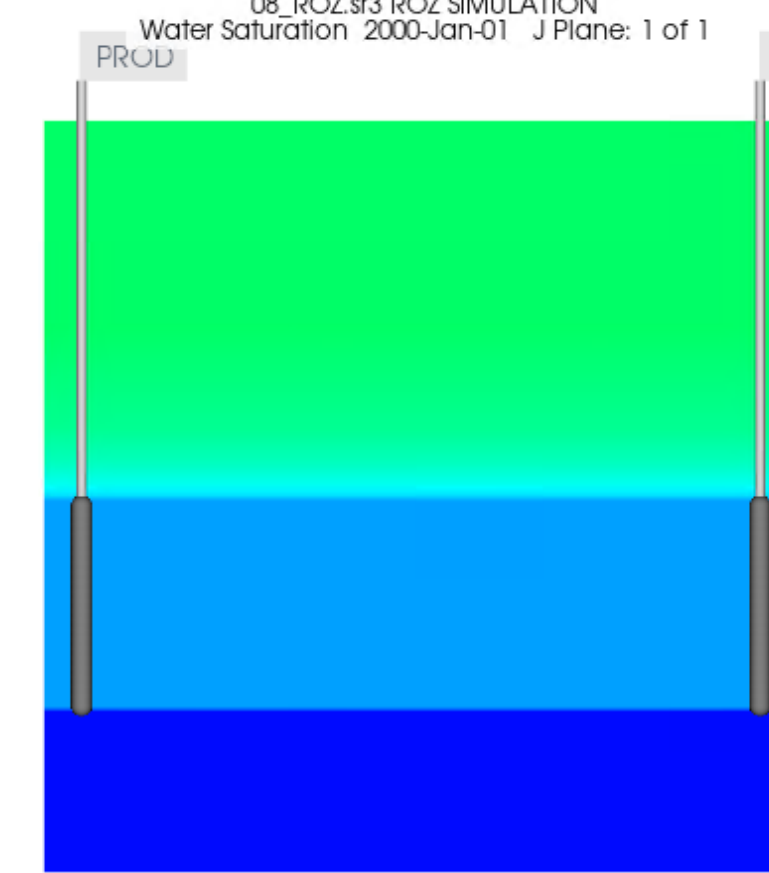
ROZ Initialization Project



Simulated pre and post imbibition saturation profile



Enumeration without Pc shift – NFC not satisfied



Water saturation grid displaying model setup with an injector and a producer completed in the ROZ at opposite ends of the grid

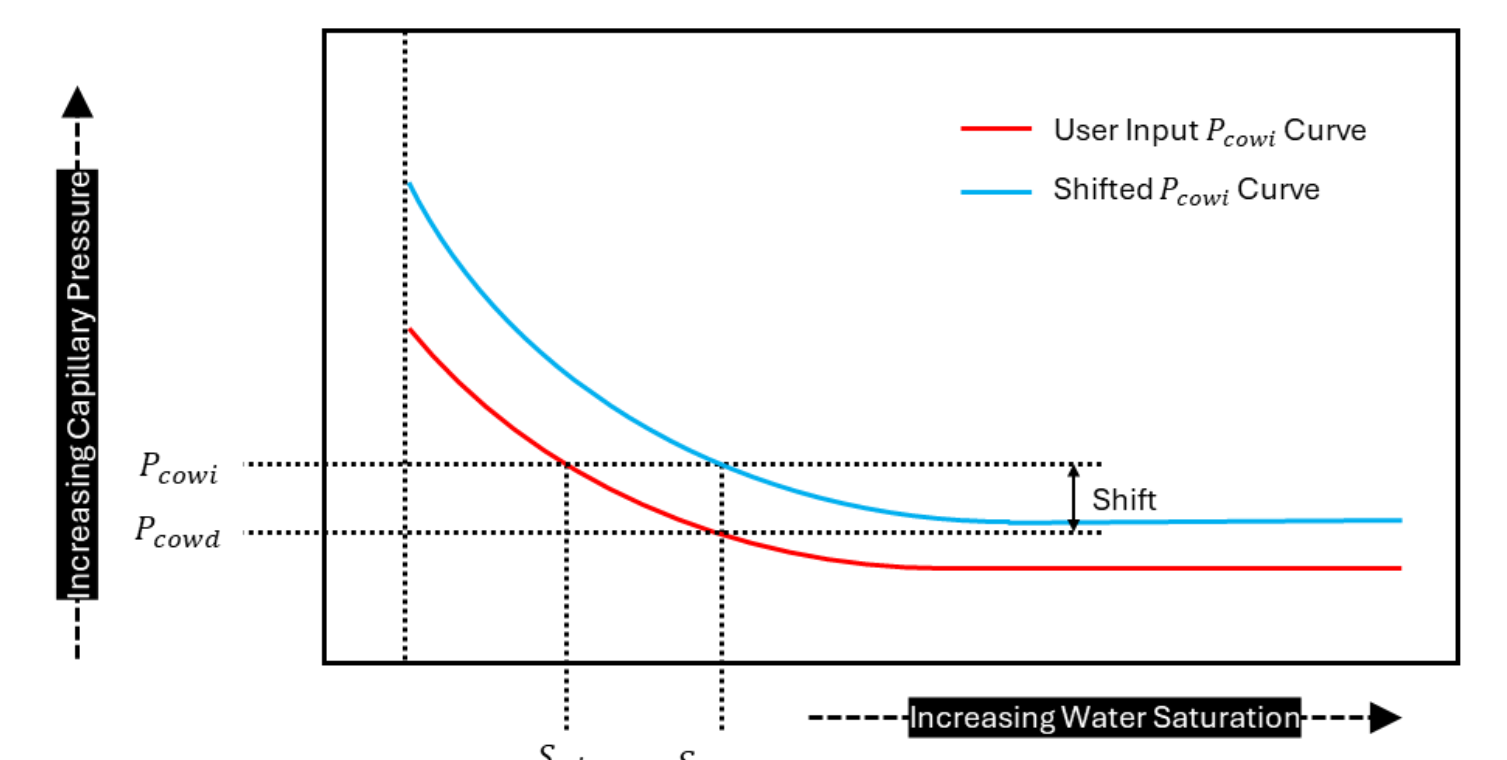
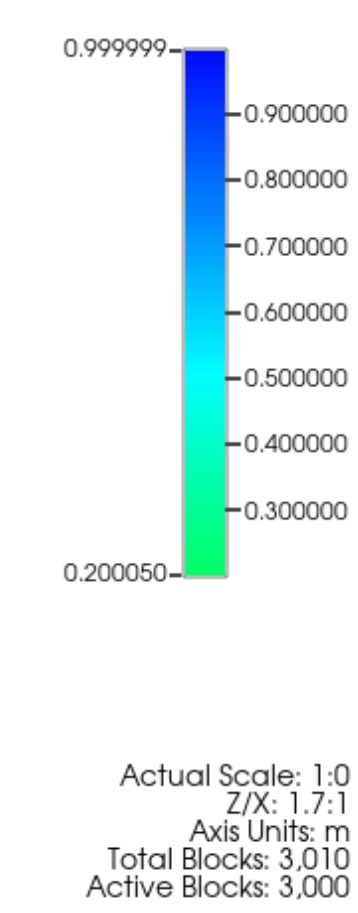
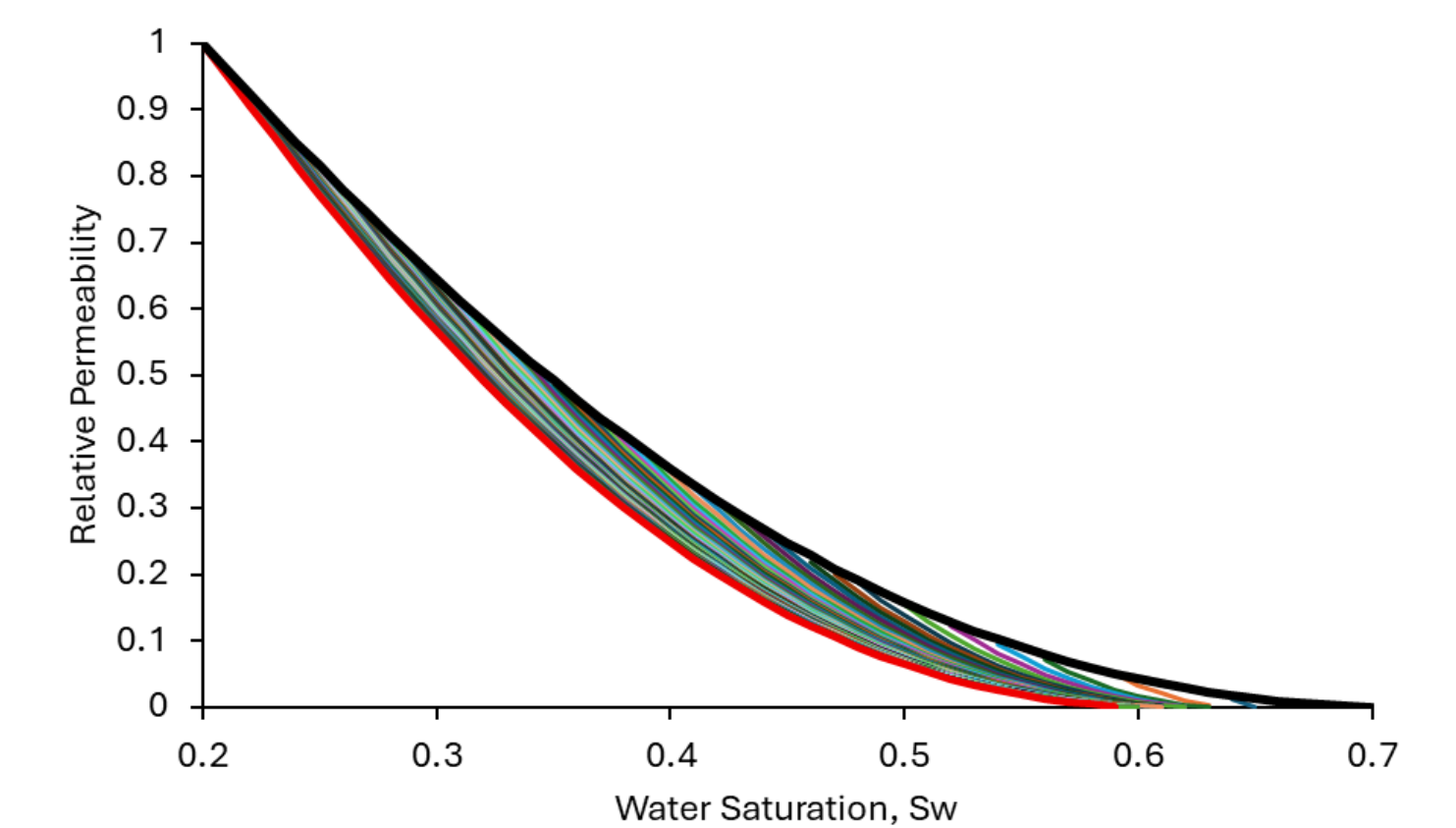
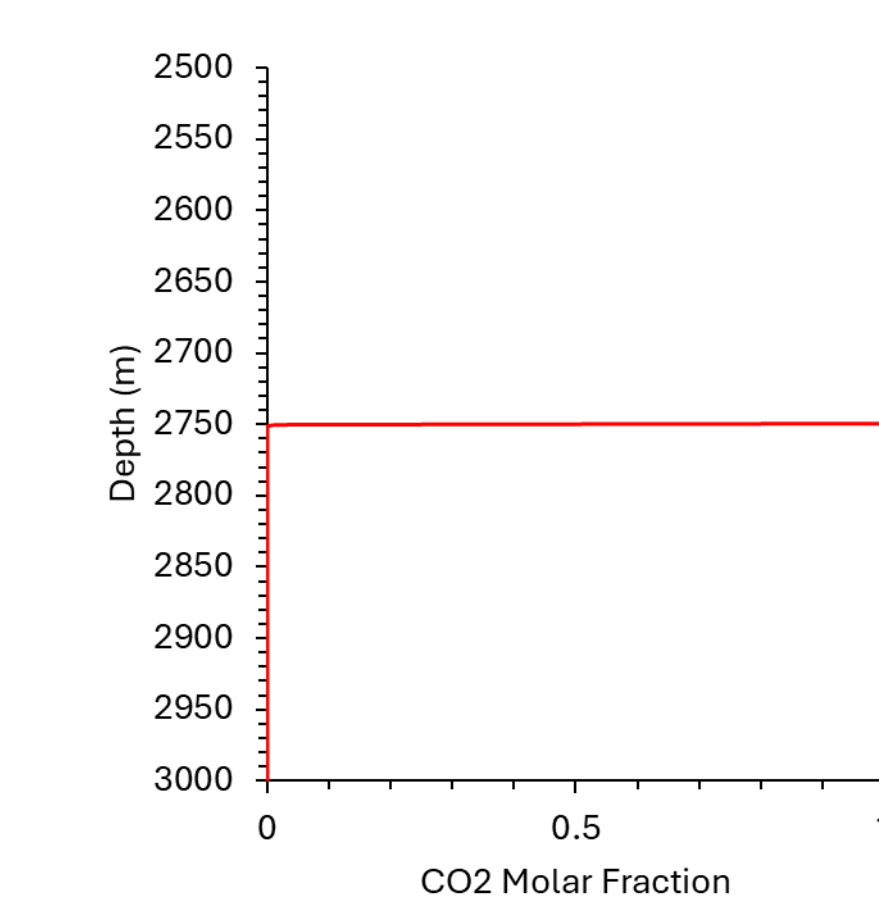


Diagram depicting how simulators apply Pc shift to satisfy the "no flow condition"

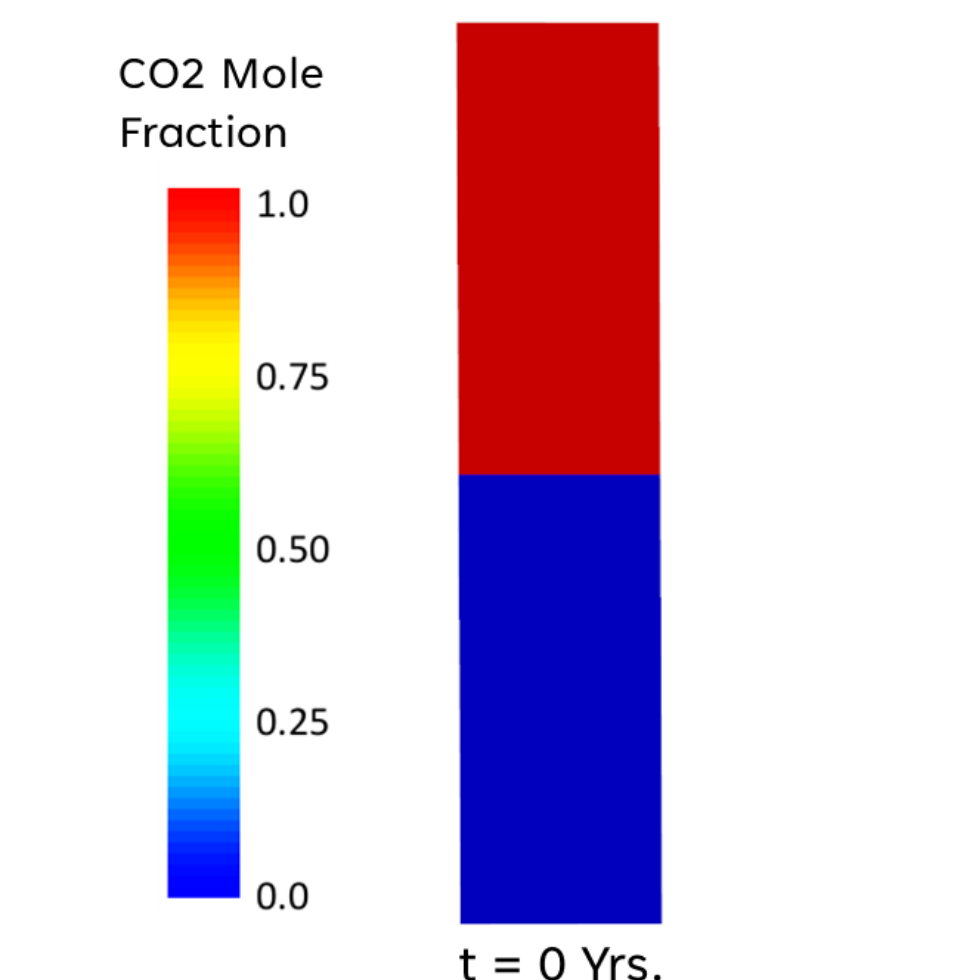


Kro curves showing impact of imbibition on trapped oil saturation (used for EPS)

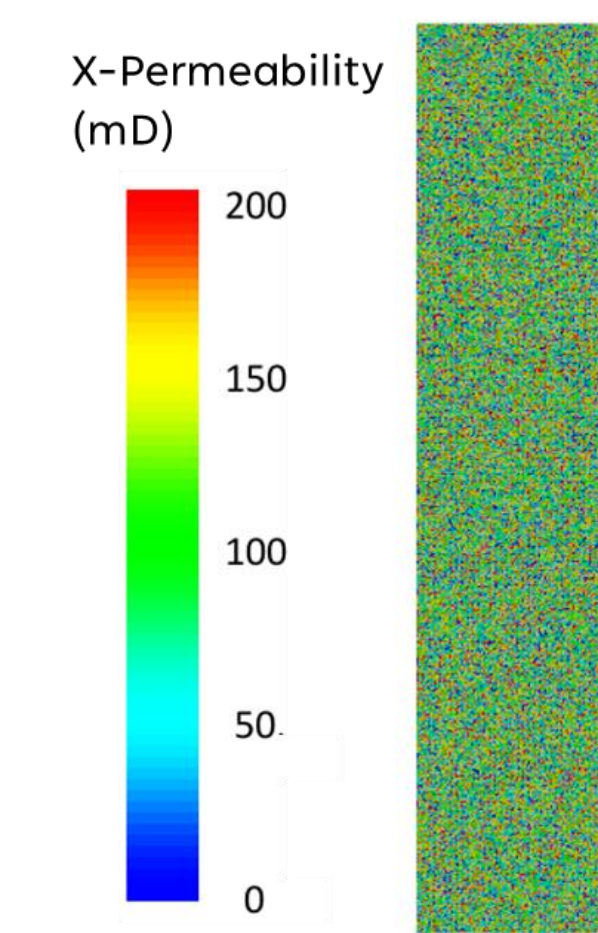
1 & 2D Mixing in Depleted Gas Reservoirs



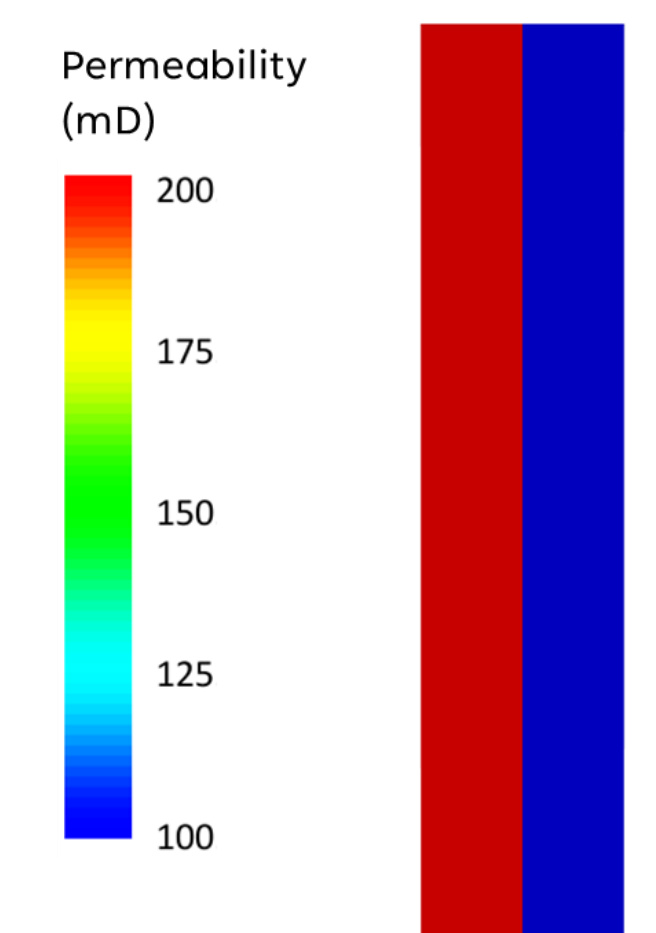
CO₂ Mole% in a 1D Column



CO₂ Mole% in a 2D Column



Heterogeneous Permeability Profile



Vertical strips of differing permeability fields

WHY / PURPOSE

ROZ Initialization Project

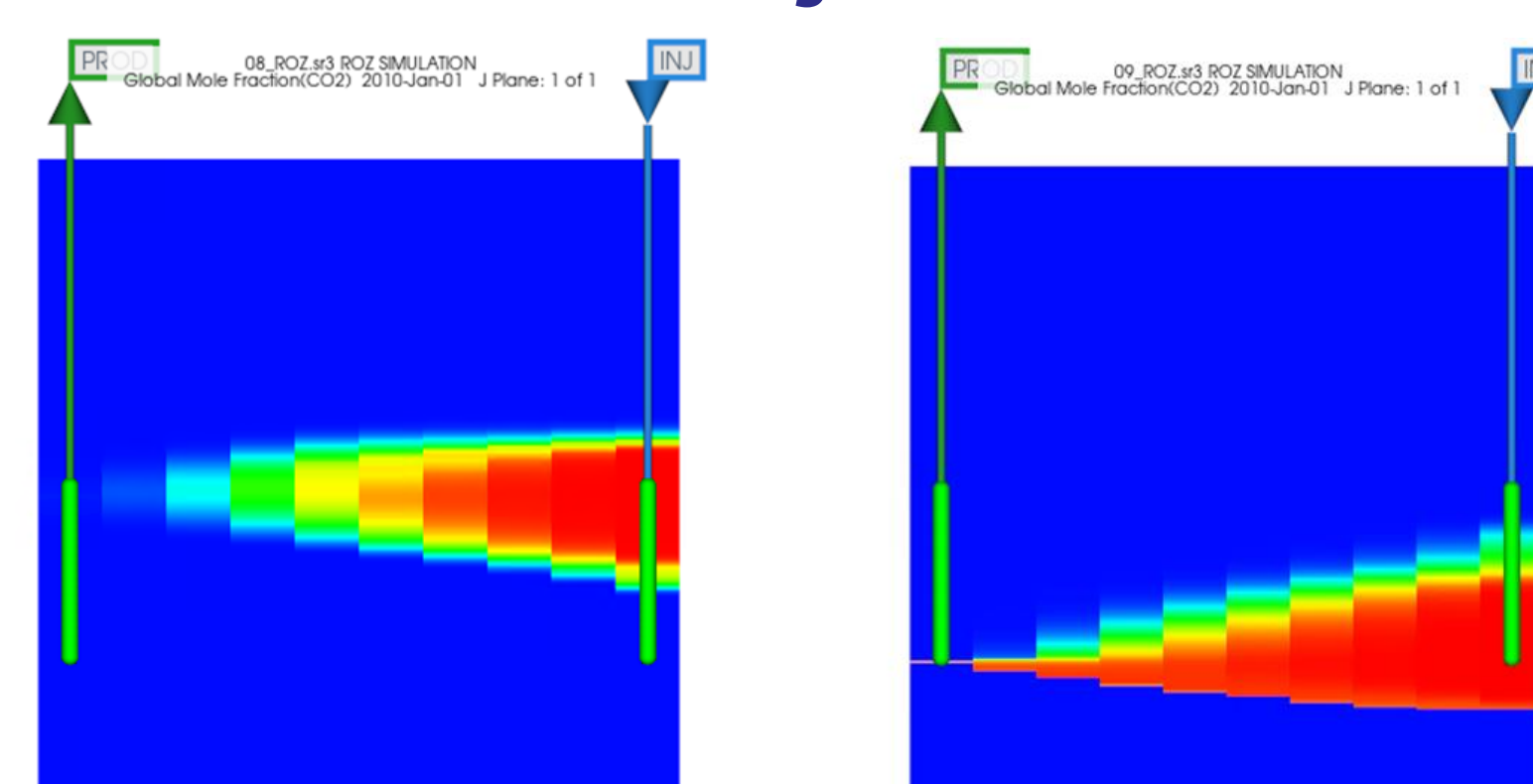
- ❑ To quantify the impact of different initialization techniques on oil recovery forecasts, CO₂ breakthrough, and storage efficiency in ROZs.
- ❑ To determine whether common initialization methods introduce artifacts that distort plume migration and production response.
- ❑ To propose practical solutions that incorporate hysteresis-consistent initialization while maintaining computational efficiency

1 & 2D Mixing in Depleted Gas Reservoirs

- ❑ To evaluate the role of lateral permeability and dimensionality in enabling convective mixing and realistic segregation.
- ❑ To highlight numerical artifacts and non-ideal gas effects that may distort forecasts of CO₂ storage capacity.
- ❑ To determine whether 1D models can accurately simulate gravity segregation and CO₂-CH₄ mixing.

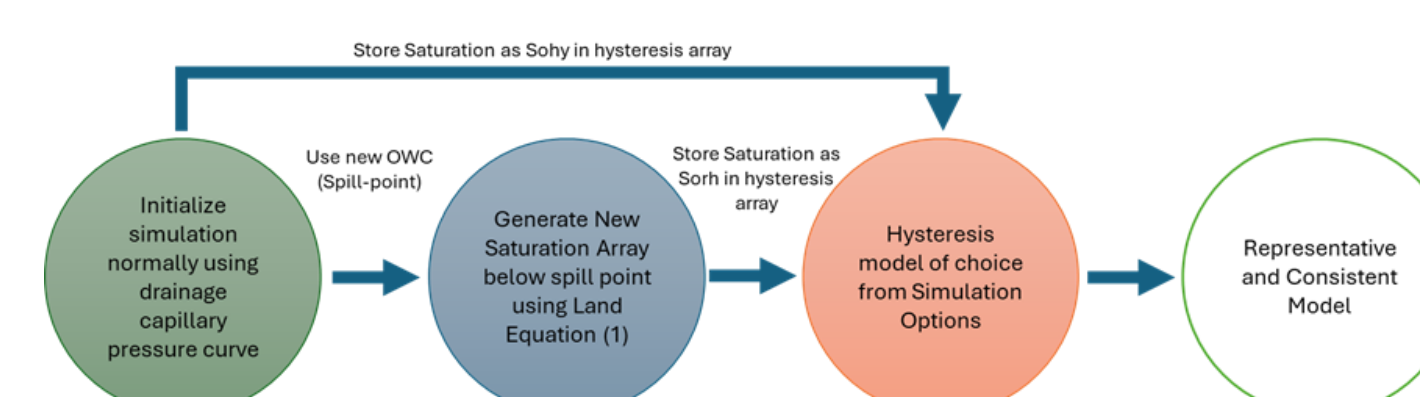
RESULTS

ROZ Initialization Project

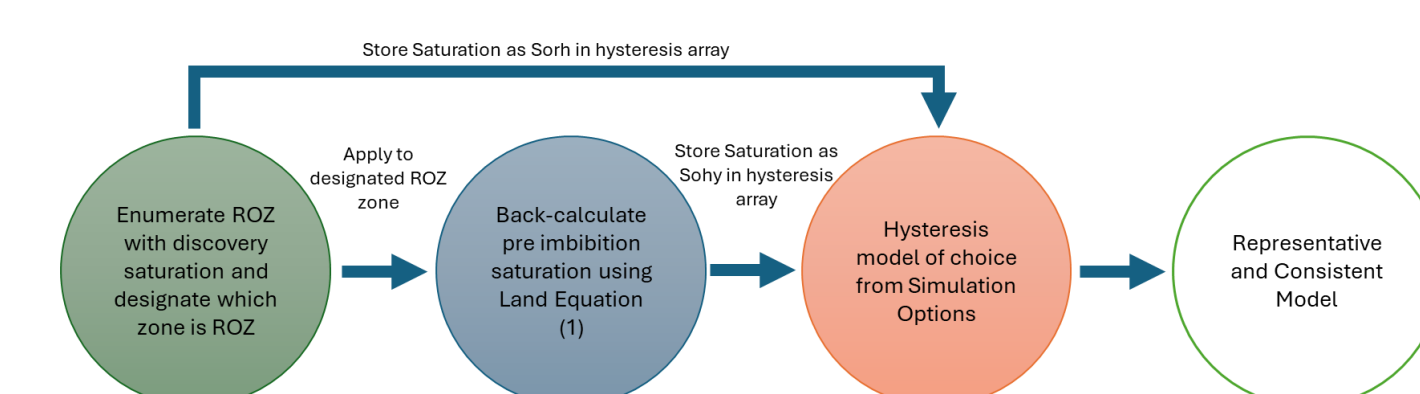


CO₂ Plume after 10 Years of Injection
Base case (left) vs Pc shift enumeration (right)

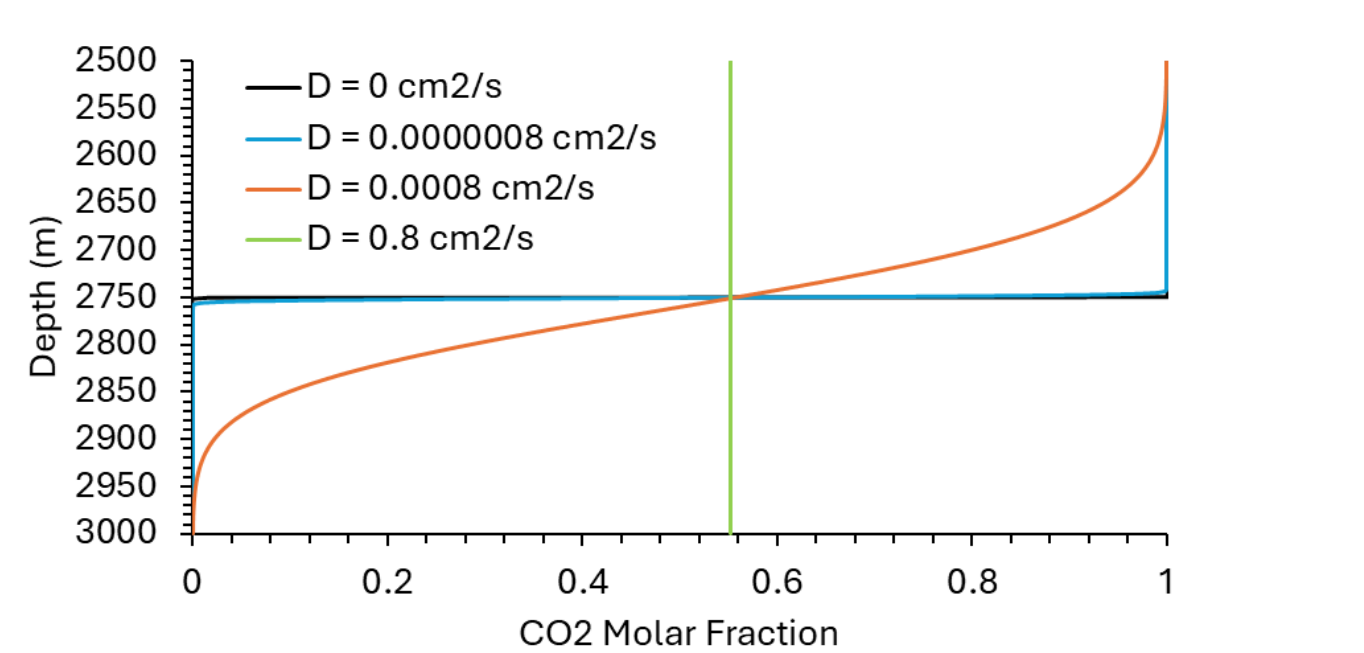
Proposed Solution 1



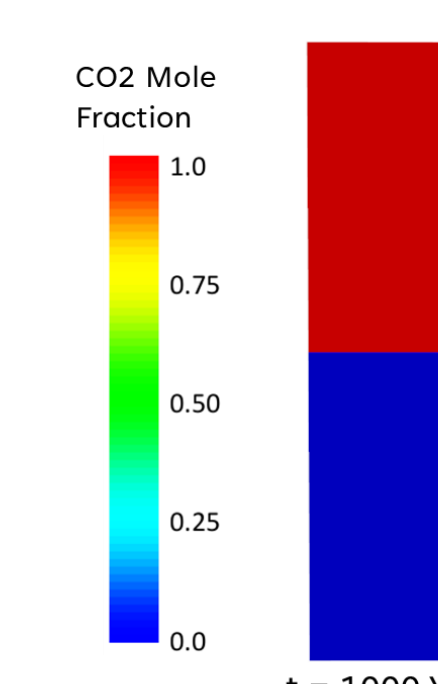
Proposed Solution 2



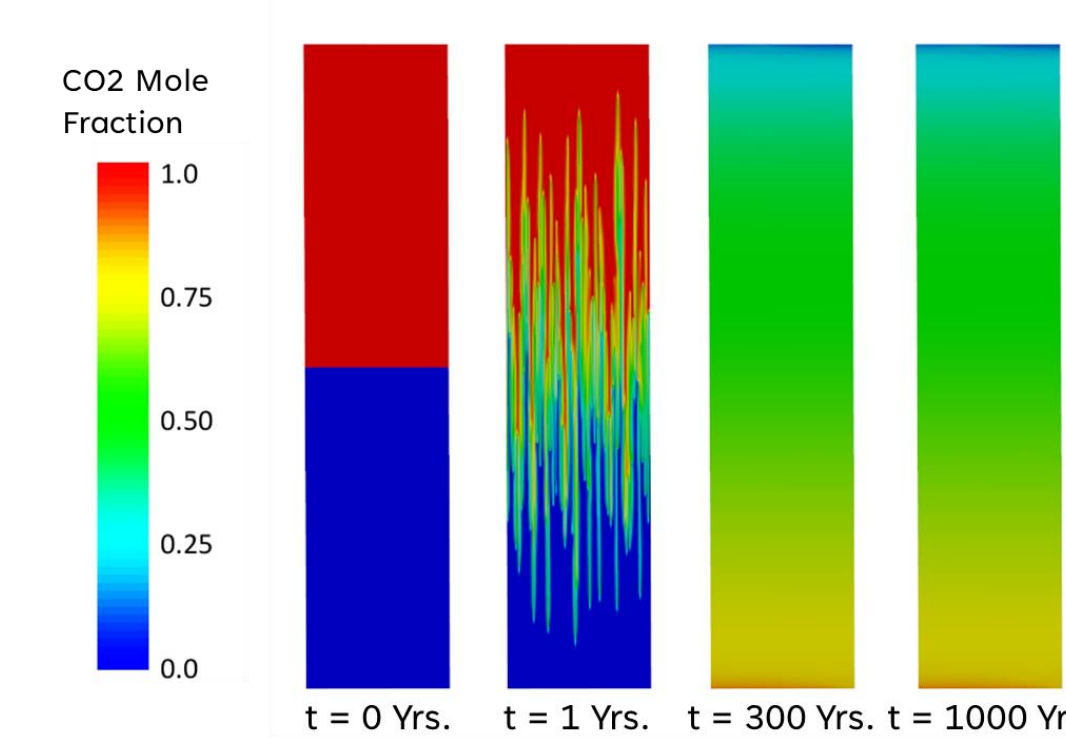
1 & 2D Mixing in Depleted Gas Reservoirs



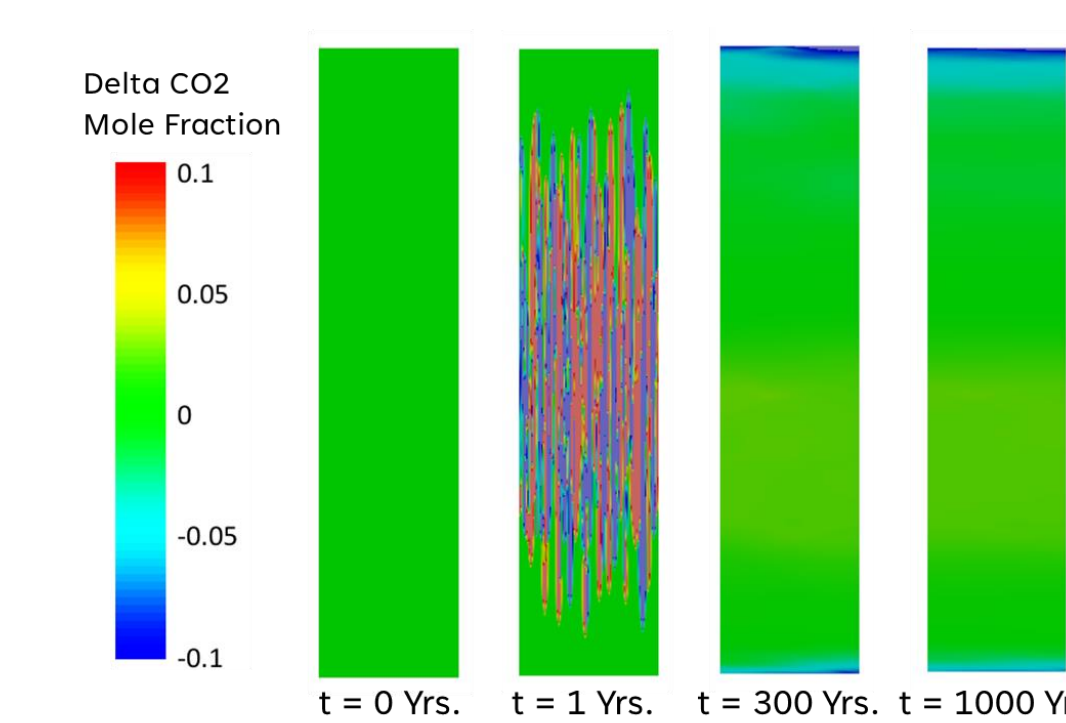
CO₂ Mole% in a 1D column with varying DC



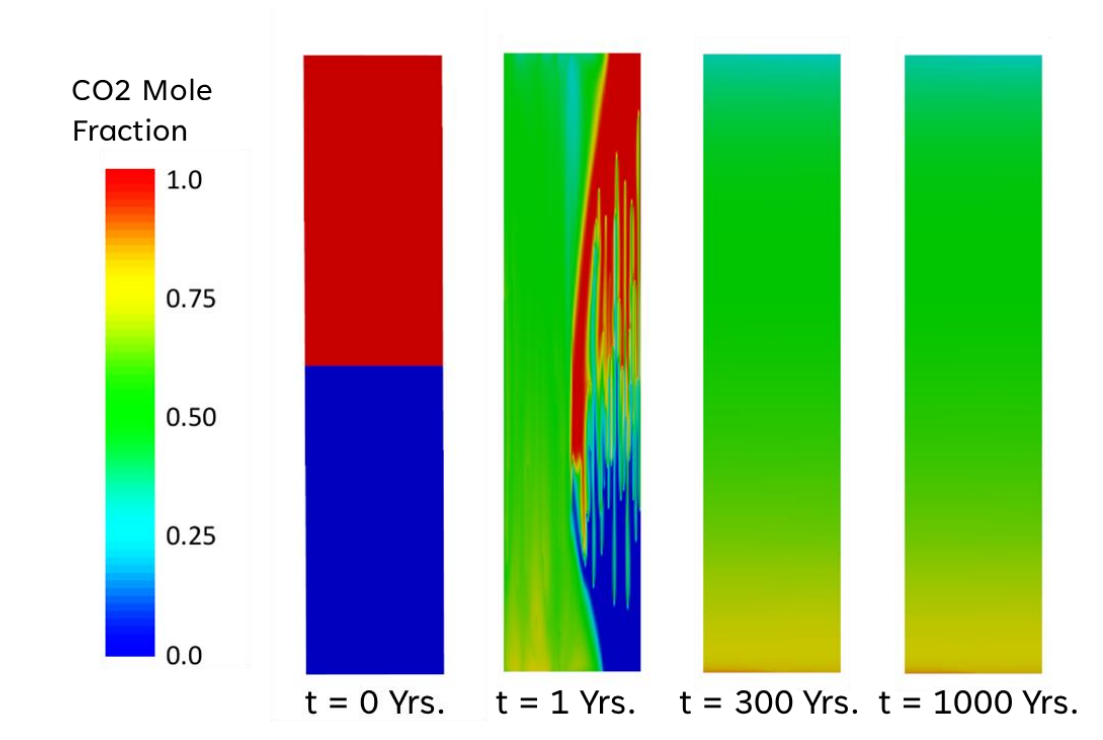
CO₂ Mole% in a 2D column with Zero Kx and DC



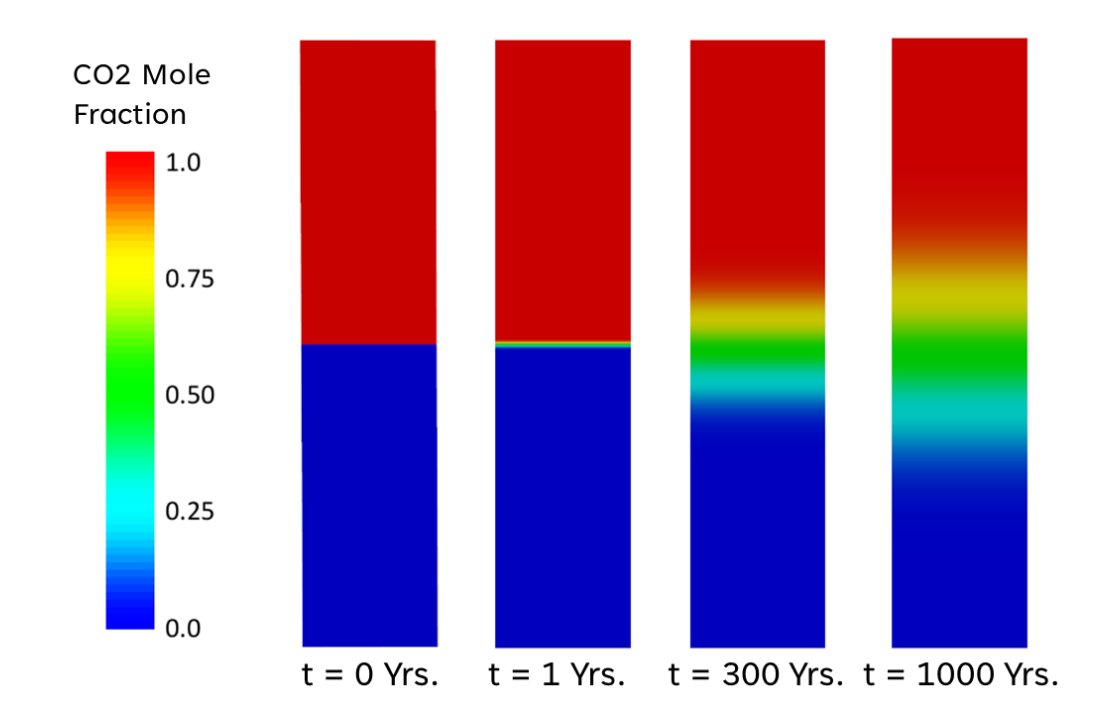
No diffusion coefficient.



Delta when modifying one cell's k



Two vertical strips of varying Kz



High DC and Zero Kx

Work is from two manuscripts submitted for publication and are currently under peer review.

[1] Quantifying the Impact of Residual Oil Zone Simulation Initialization on CO₂ Storage and Recovery Forecasts and Proposing a Physically Consistent Solution
[2] 1D Simulation Reveals Critical Role of Lateral Permeability in Modeling Gravity Segregation During CO₂ Storage in Depleted Hydrocarbon Reservoirs

Acknowledgments:

