Computational Issues for Modeling and Optimizing CO_2 Sequestration

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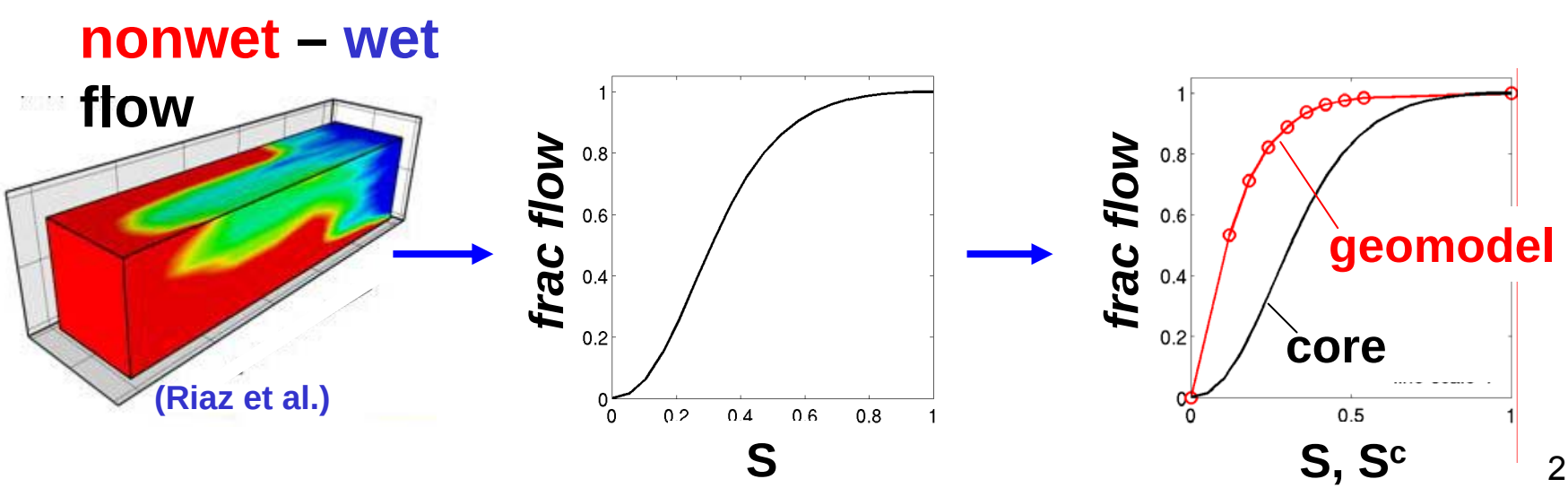
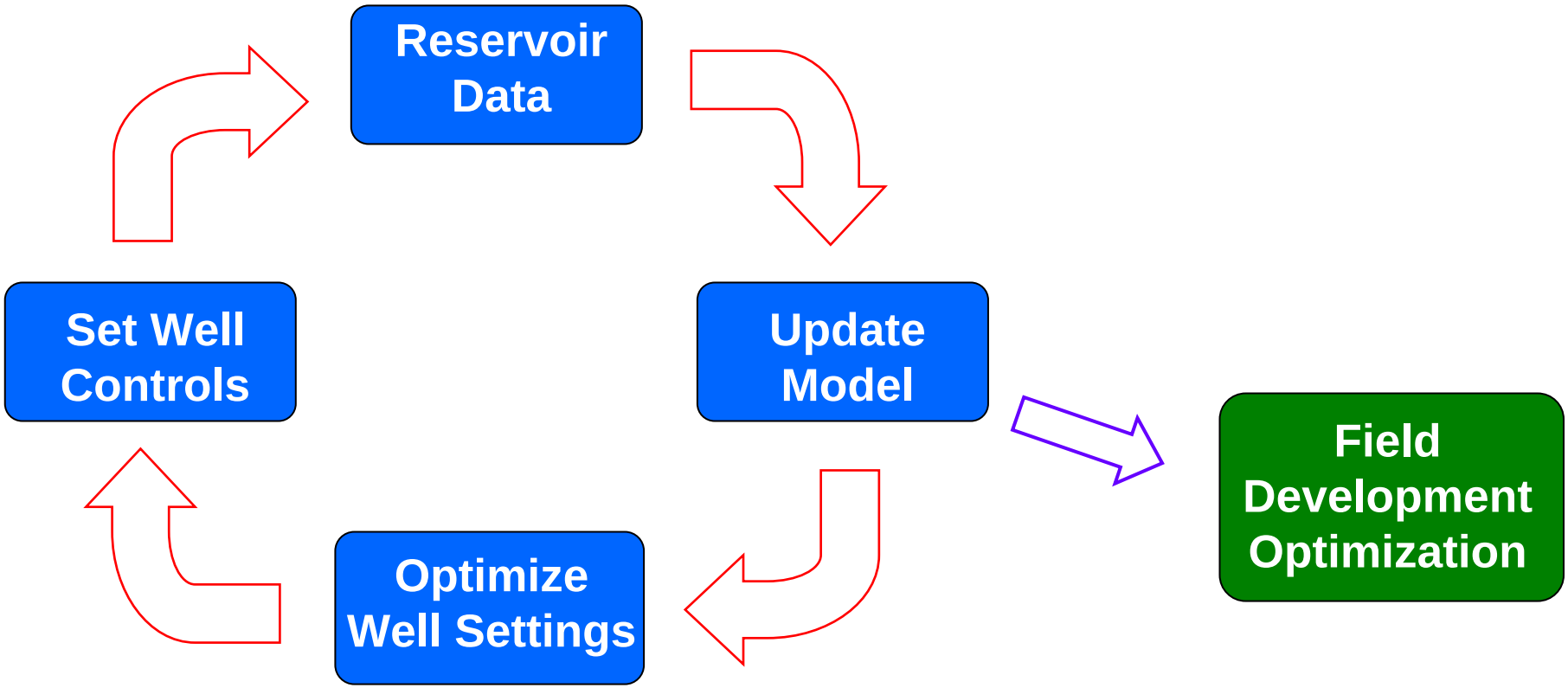
- Treatment of multiscale effects (pore to field-scale), multiphysics (coupled flow, geomechanics, geochemistry), near-well phenomena
- Incorporation of computational optimization and closed-loop modeling procedures
- Uncertainty assessment and risk management

Multiscale Effects on Flow

- Aquifer scale (km) to pore scale (~10 μm)
- Intermediate scales:
  - Core or log (1-10 cm)
  - Geomodel (1-10 m)
  - Simulation block (10-100 m)



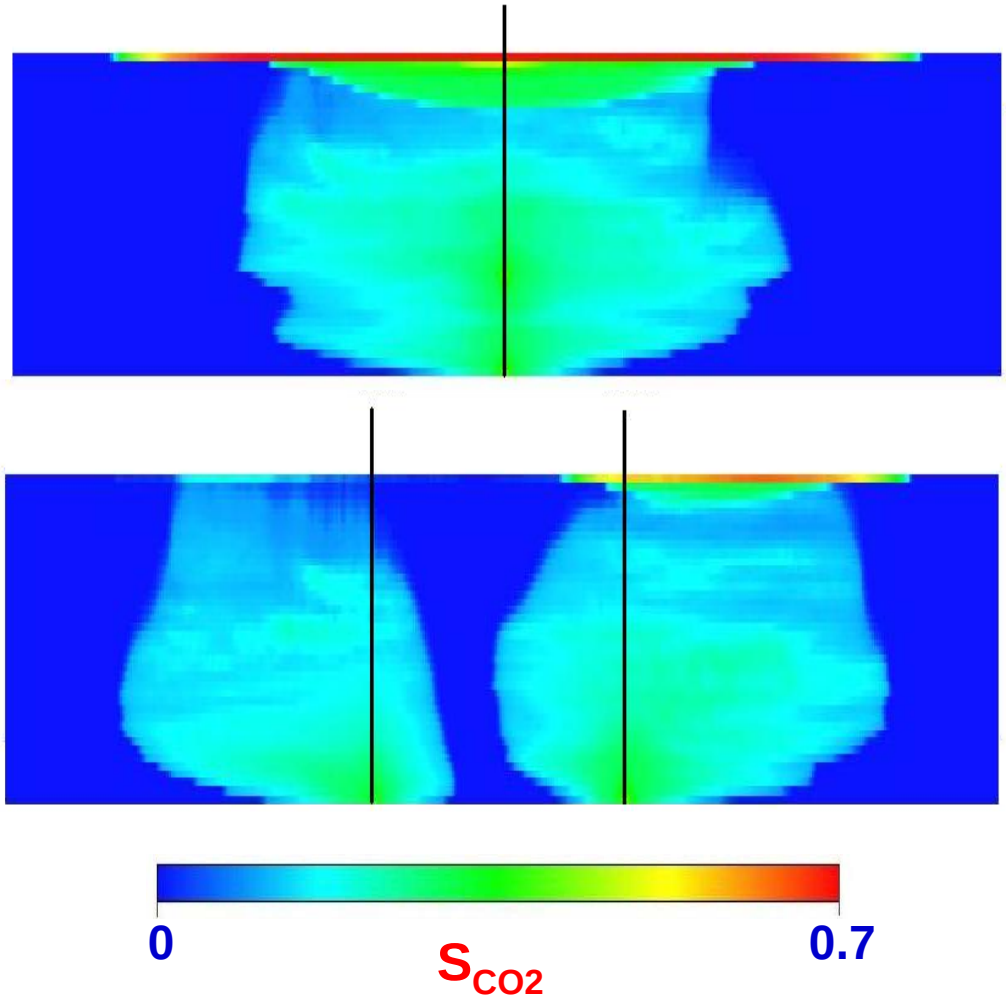
Closed-loop (Smart Field) Modeling



- Optimization & model update are computationally intensive; uncertainty quantification is essential but challenging

Optimization of CO_2 Storage

- Objective: minimize structural trapping (ave CO_2 saturation in top layer $\langle S_{CO2} \rangle$), idealized (2D) cases



1 well base case:

$\langle S_{CO2} \rangle = 0.53$

2 wells, optimized rates:

$\langle S_{CO2} \rangle = 0.21$

(from Kumar, 2007)