

Update on CCS Research at the GCCC

Susan Hovorka
Gulf Coast Carbon Center
Bureau of Economic Geology
Jackson School of Geosciences

CAGS3 CCS workshop in Urumqi, Xinjiang, China



BUREAU OF
ECONOMIC
GEOLOGY



TEXAS Geosciences
The University of Texas at Austin
Jackson School of Geosciences



Gulf Coast Carbon Center

- Established 2002
- Industrial Associates program
 - At University of Texas at Austin
 - Bureau of Economic Geology
- Multi-year “Big Plan”
- Strong leverage via sponsored research
- Field projects

Gulf Coast Carbon Center Current Research

GCCC Major Themes

Capacity Estimation

Unconventional EOR

**Monitoring Methods
Optimization**

Analog Studies

Knowledge Sharing

Major Funded Projects

DOE SECARB – Phase III

DOE-Offshore Miocene

Net Carbon Negative Oil

DOE CCPI: NRG – West Ranch

DOE EASI-Tool

DOE Intelligent Design

GCCC Industrial Associates

**Sponsor funded
projects**

**Links to
CCS JIP**

**Links to
Capture**

**Links to
BES
CFSES**

**Links US
and global**

Capacity Estimation

- What limits storage capacity?
 - Pressure limits
 - EASi-Tool
<http://www.beg.utexas.edu/gccc/EASiTool/index.php>
 - Consider capacity under open and closed boundary conditions
 - Lateral migration
 - Rates and process of migration far from injection point

Easi-tool Capacity calculation

Seyyed Hossieni

The screenshot displays the EasiToolGUI interface, which is used for CO2 Geological Capacity Estimation. The interface is divided into several sections:

- 1-RESERVOIR PARAMETERS:** Includes input fields for Pressure [MPa], Temperature [C], Thickness [m], Salinity [mol/Kg], Porosity, Permeability [mD], Rock Compressibility [1/Pa], Reservoir Area [km^2], Basin Area [km^2], and Boundary Condition.
- 2-RELATIVE PERMEABILITY (Brooks-Corey):** Includes input fields for Residual Water Saturation, Residual Gas Saturation, m, n, Kra0, and Krg0.
- 3-SIMULATION PARAMETERS:** Includes Simulation Time [years], Injection Well Radius [m], Max Injection Pressure [MPa], Density of Porous Media [Kg/m3], Total Stress Ratio (V/H), Biot Coefficient, Poisson's ratio, Coefficient of Thermal Expansion [1/K], Bottom Hole Temperature Drop [K], and Young's Modulus [GPa].
- 4-NPV:** Includes input fields for Drilling Cost [\$M/well], Operation Cost [\$K/well/year], Monitoring Cost [\$K/year/km^2], Tax Credit (\$/ton), Extractors Drilling Cost [\$M/well], and Extractors Operation Cost [\$K/well/year].
- 5-EXTRACTION PARAMETERS:** Includes Number of Extractors, Minimum Extraction Pressure [MPa], Maximum Extraction Rate [m^3/day/well], and a Run button.
- 6-RESULT CONTROLS:** Includes Number of Injection Wells (set to 25), Export Image and Output Files (Slow) checkbox, and a Visit our website button.

On the right side of the interface, there are four plots:

- Capacity, Mitons of CO2 vs Number of Injection Wells:** A line graph showing capacity increasing from approximately 40 to 70 Mitons as the number of injection wells increases from 0 to 100. A data point is highlighted at X: 25, Y: 60.22.
- NPV, \$M vs Number of Injection Wells:** A line graph showing NPV decreasing from approximately 100 to -600 \$M as the number of injection wells increases from 0 to 100.
- CO2 Plume Extension:** A 2D plot showing the spatial distribution of CO2 plume extension with red circles and blue triangles.
- Well Rate (ton/day):** A 2D plot showing the spatial distribution of well rates with red circles and blue triangles.

At the bottom right, there is a horizontal bar chart showing the sensitivity of various parameters on Capacity. The parameters listed are Permeability, Thickness, Temperature, Porosity, Rock Comp., Krg0, m, Sgc, Sar, Kra0, n, Salinity, and Pressure. Permeability and Thickness show the highest sensitivity to capacity changes.

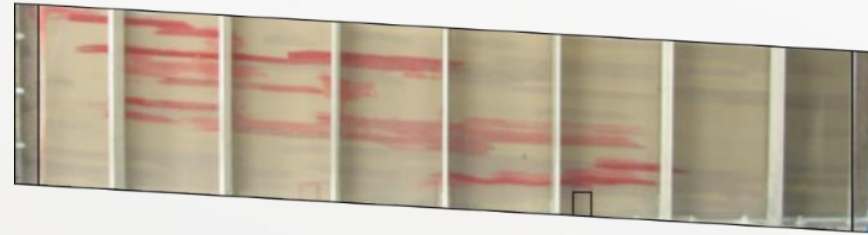
The EASiTool logo and "CO2 Geological Capacity Estimation" are visible at the bottom center.

Comparison between Permedia and physical models

Luca Trevisan

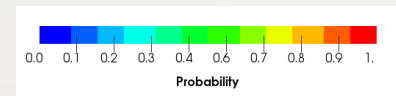
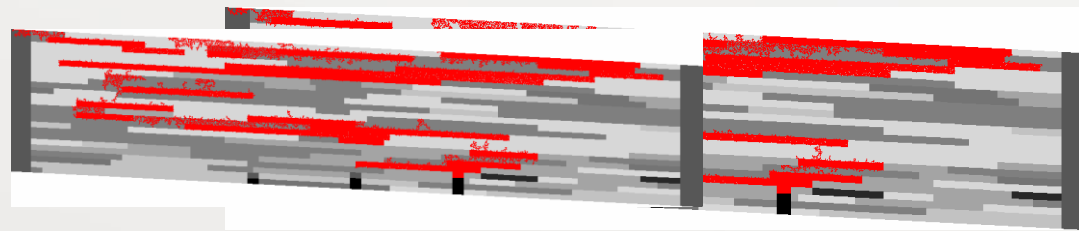
Observations from previous sandbox experiments performed under capillary-, buoyancy-dominated flow, *Trevisan et al. (2017) WRR*

Stochastic modelling approach is able to account for uncertainty of individual numerical simulations



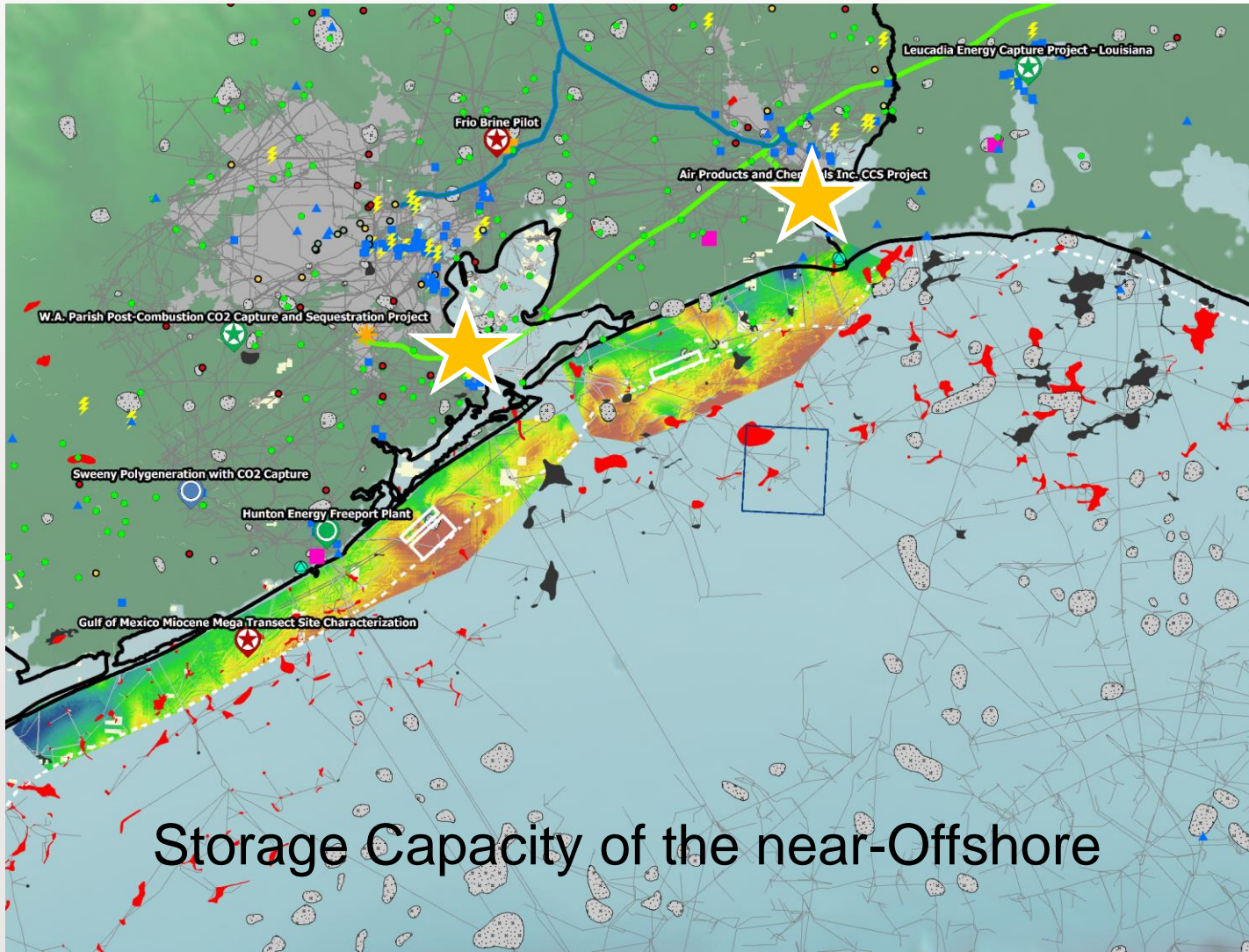
Simulation result for 1 realization

Probability map for an ensemble of 50 realizations



Simulation results for 50 realizations of P_{th} field

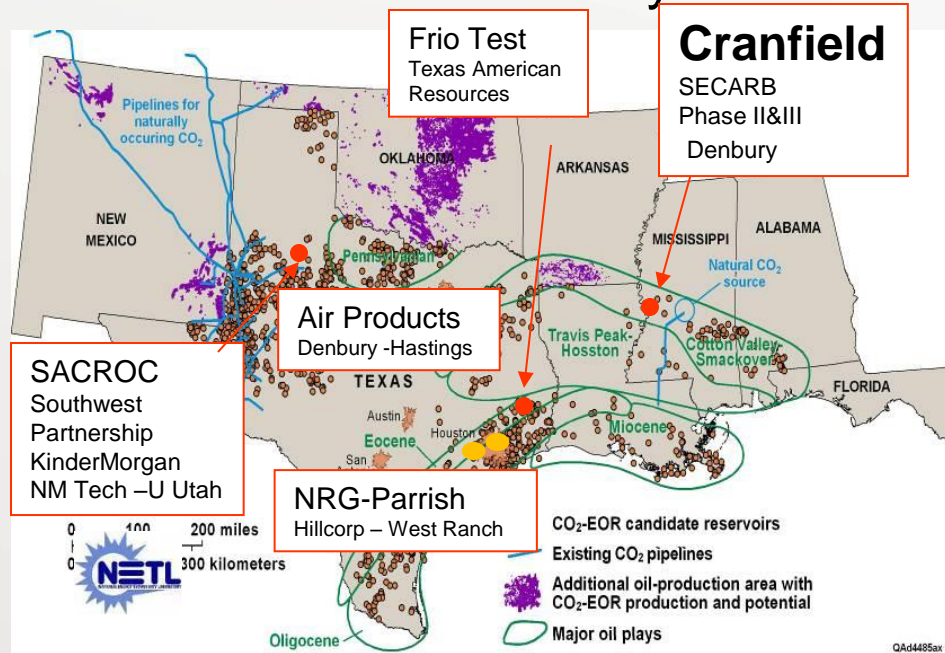




Optimization of Monitoring

- Field tests for real world solutions and validations
- Development of optimized “process based’ soil gas methods
- Real time instruments for surveillance of groundwater
- Above Zone “AZMI” installations.

GCCC Field Tests for Monitoring Verification and Accounting DOE-NETL and Industry Hosts



Optimization of Monitoring --ALPMI method Assessment of Low Probability Material Impact

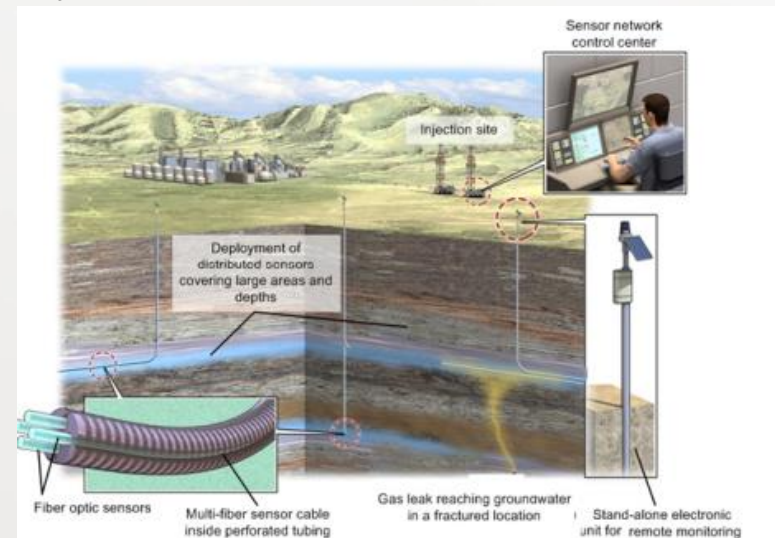
- 1) Define metrics of project success
 - Mass injected
 - Avoid unacceptable project outcomes
 - Loss of CO₂ from secure storage
 - Unacceptable Seismicity
 - Damage to resource
- “Material Impact”
 - Defined quantitatively and with a level of certainty
 - “low probability” therefor need to prepare for non-detect.
 - Noise of setting and sensitivity of monitoring array

Real-time sensors for environmental surveillance

- Current geochemical monitoring requires water samples be collected periodically and analysed either on-site or in a chemical laboratory
- Labour and cost intensive

Can we use sensors for real-time in situ monitoring of geochemical parameters in groundwater?

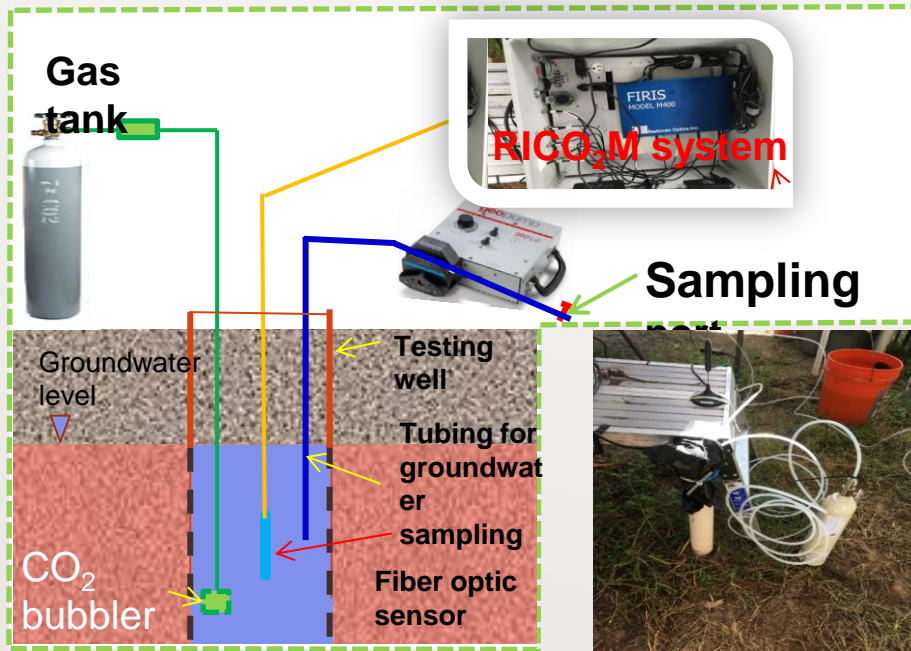
To make geochemical monitoring as simple as pressure monitoring



Changbing Yang, GCCC

Field Demonstration at the Brackenridge Field Laboratory

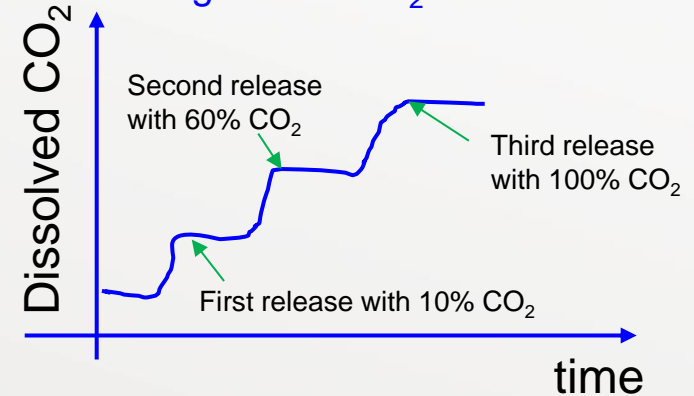
Configuration of the testing well



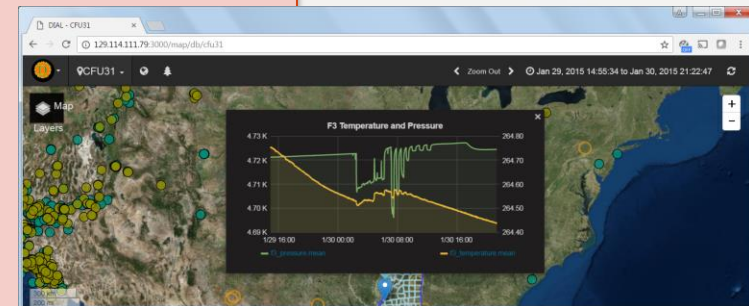
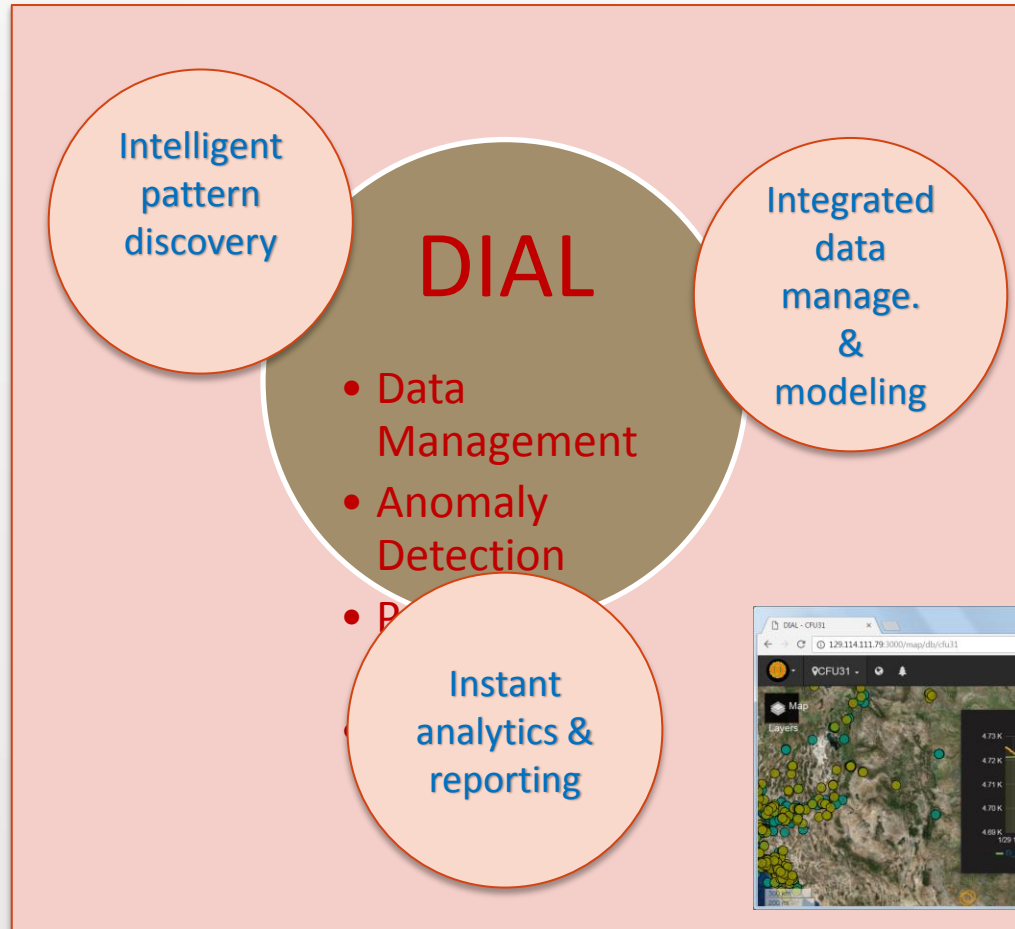
Not to scale

Step-wise CO₂ release tests

Expected response of dissolved CO₂ in the testing well to CO₂ release

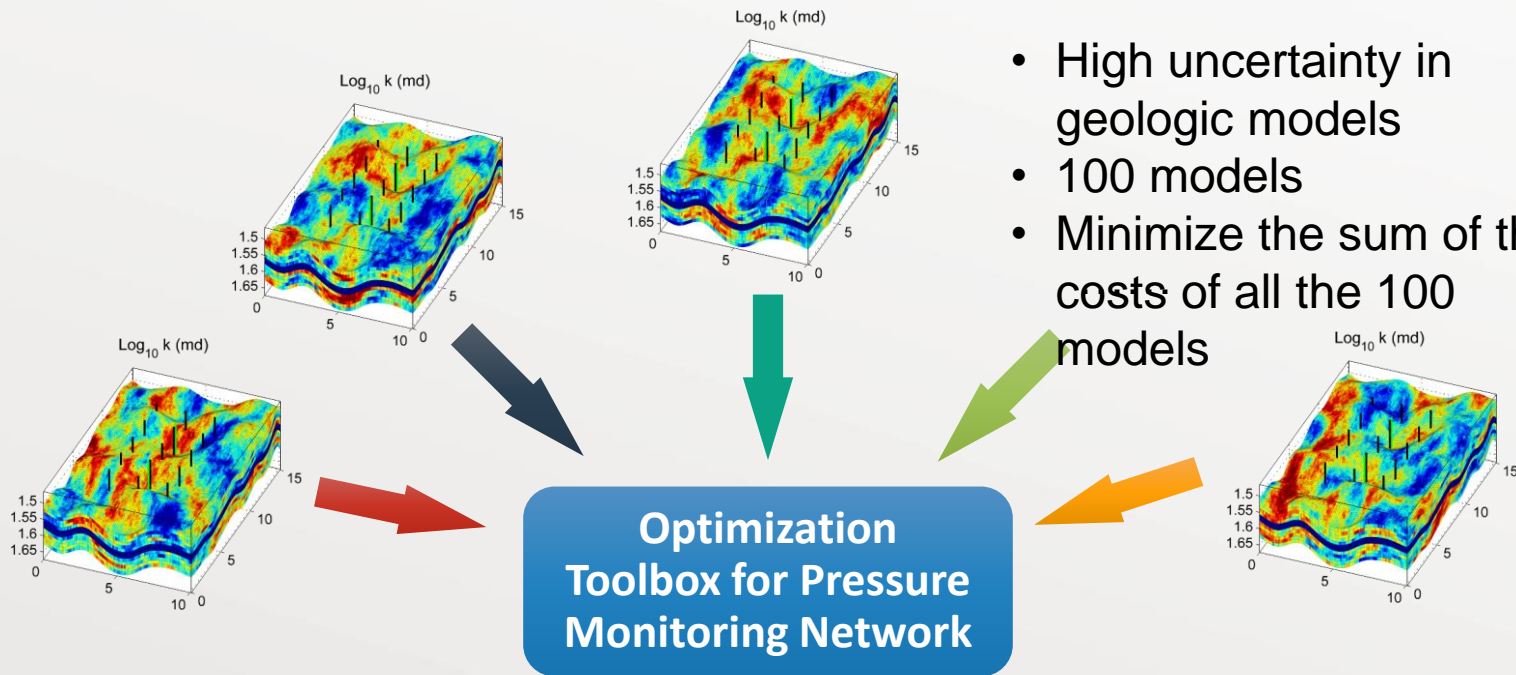


- On-site measurements of pH and alkalinity
- On-site measurements of dissolved CO₂ with a CarbonQC



Alex Sun and Hoonyoung Jeong

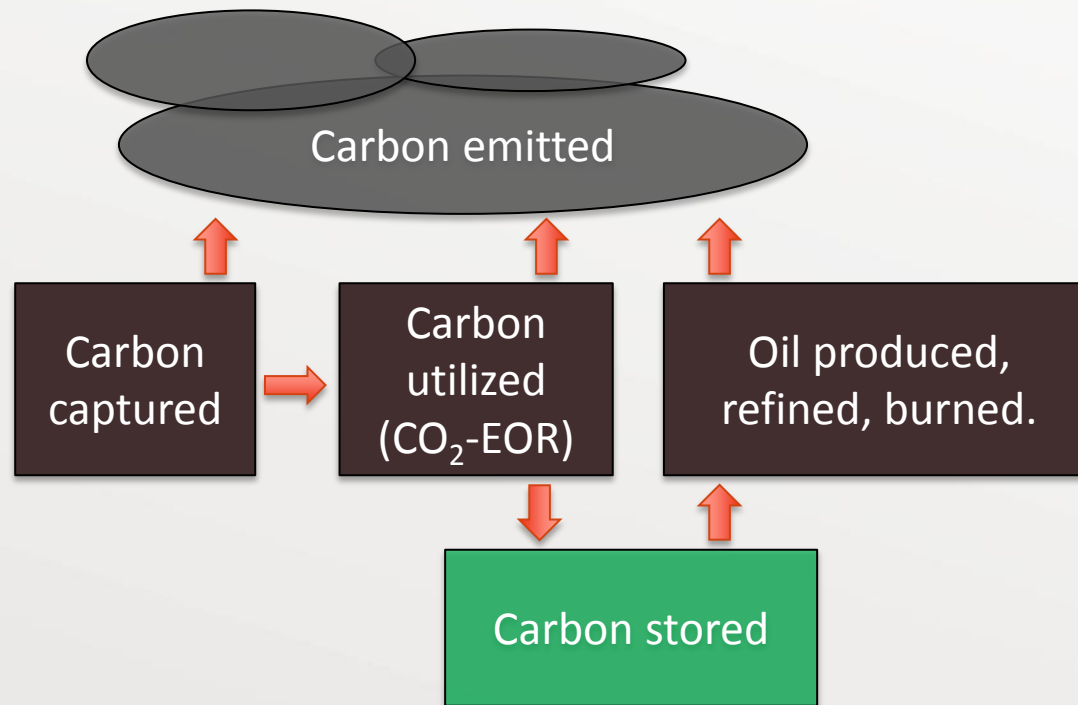
Considering Geological Uncertainty in monitoring



- High uncertainty in geologic models
- 100 models
- Minimize the sum of the costs of all the 100 models

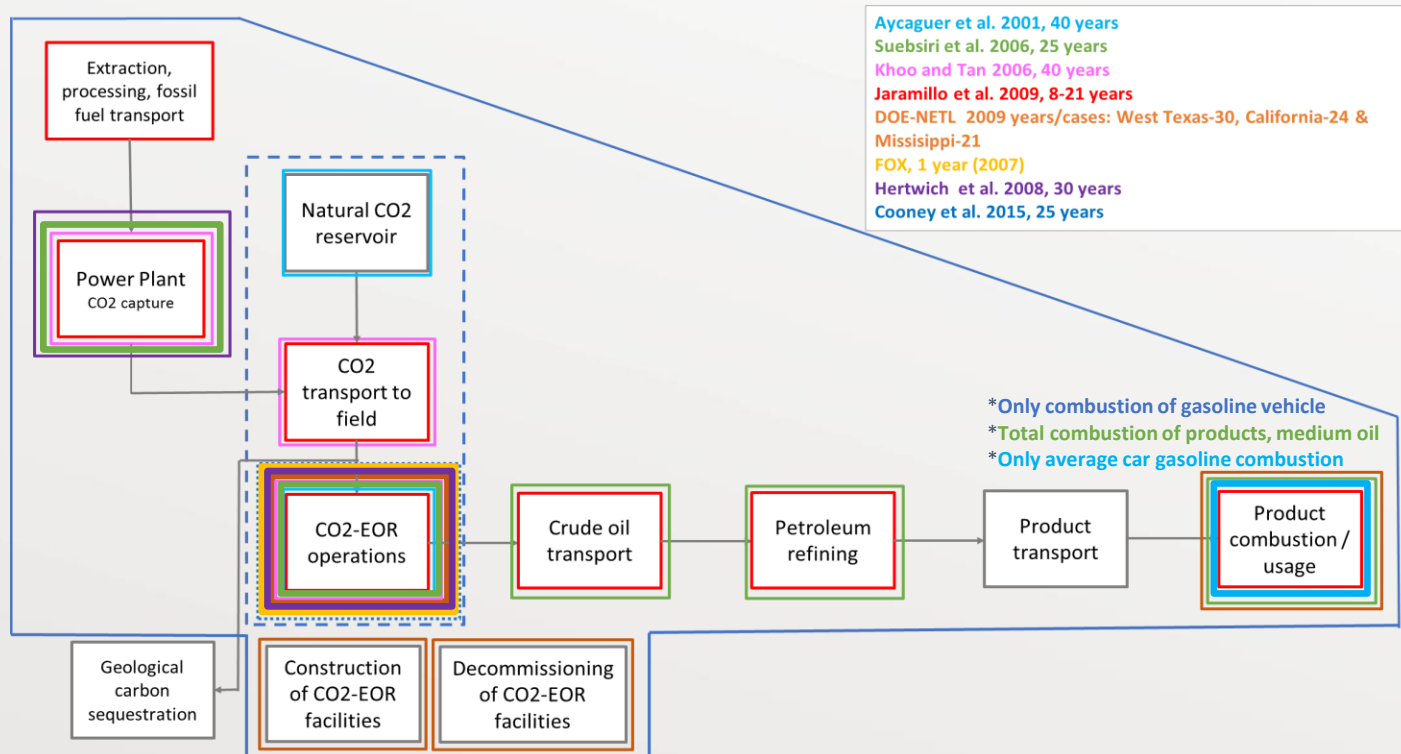
Life Cycle for CO₂ Enhanced Oil Recovery

- Is CO₂-EOR a valid option for greenhouse gas emission reduction? Are geologically stored carbon volumes larger than direct/indirect emissions resulting from CO₂-EOR operations?



Vanessa Nunez and Ramon Gil

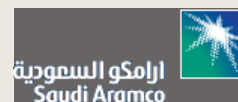
System boundaries of previous studies



Vanessa Nunez and Ramon Gil



www.gulfcoastcarbon.org



LBNL
LLNL
ORNL
NETL
SNL
Mississippi State U
U of Mississippi
SECARB
UT-PGE
UT Chem-E
CFSES- BES

UT- DoGS
UT- LBJ school
BEG- CEE
JSG – EER
Univ. Edinburgh
Univ. Durham
RITE
CO2-CRC

