Methodology for Estimating Offshore CO_2 Storage Resource Potential in Saline Aquifers

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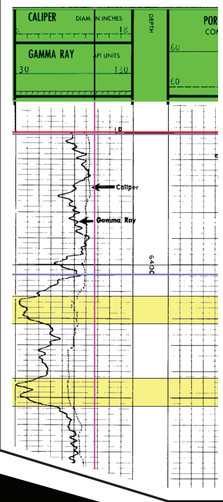
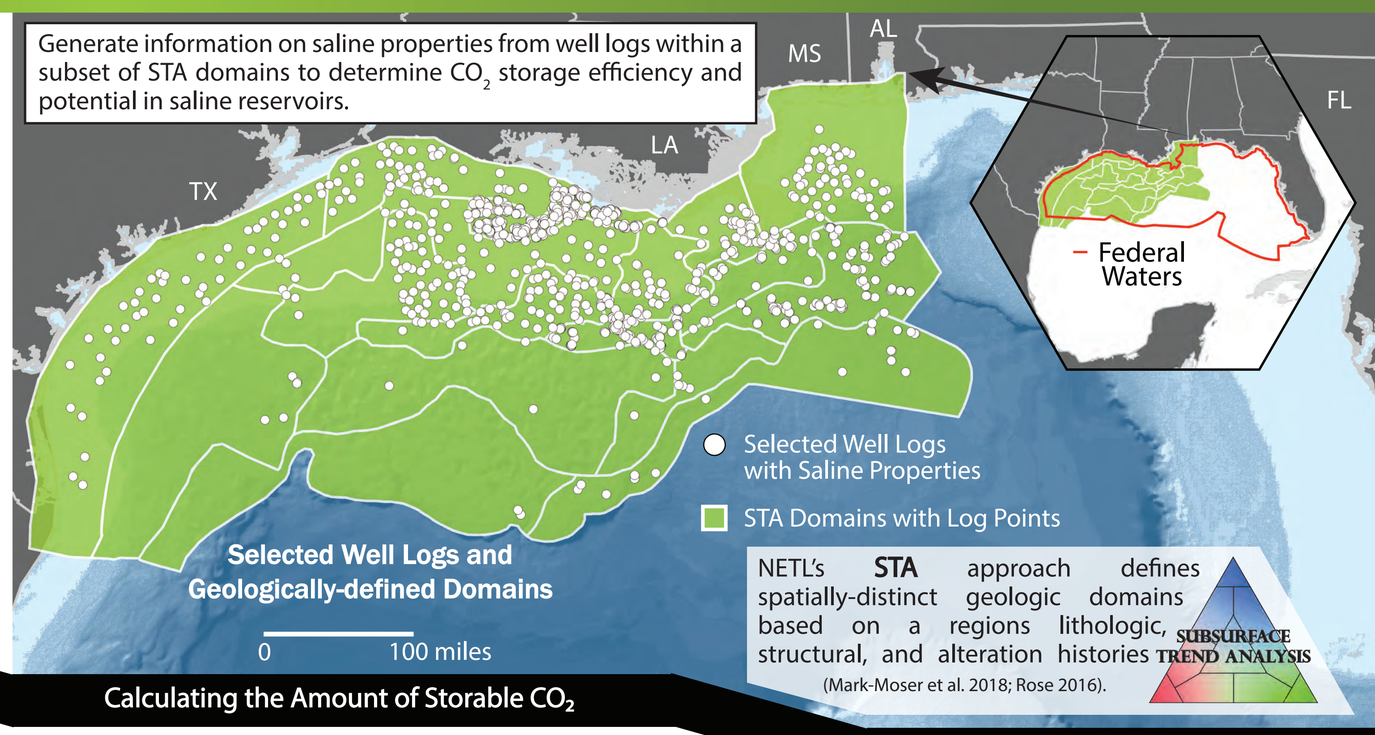
Abstract: Important differences exist between onshore and offshore geological systems that affect the capacity, cost, and permanence of CO2 storage. In particular, offshore carbon storage is an attractive alternative to onshore storage where point sources of CO2 can be co-located with subsea storage reservoirs, thereby minimizing the risks of leakage to the public. Offshore systems are typically younger, unlithified, and have higher total porosity compared to onshore systems —all considerations that affect the performance of hypothetical offshore storage efforts. In general, offshore data is more scarce than onshore data due in part to the shorter history of offshore oil exploration and production. NETL has adapted the DOE storage resource calculation methodology to incorporate available offshore public and private geodata derived from oil and gas exploration in the US waters of the Gulf of Mexico. Here we present the spatially-driven methodology for estimating offshore storage resource potential including data sources and preliminary calculations for determining efficiency factors. Efficiency factors for the offshore include effective porosity, area, and height of the sand column of interest. This poster also summarizes Phase II of this project, which leverages tools and methods from NETL's Offshore Risk Modeling suite to spatially assess potential risk factors including infrastructure, geologic, and environmental constraints.

Data Acquisition



- Applied private and public geologic data to estimate storage efficiency and the storage resource available for CO_2 in the Gulf of Mexico
- Interpret well logs for storage resource parameters: sand thickness (reservoirs), shale thickness (seal), and sand porosity
- Selected well log distributions leveraging NETL's **Subsurface Trend Analysis (STA)** (Mark-Moser et al. 2018)
- For each domain, selected at least 50 well logs, if available
- **400 location-based records** throughout **18 of the STA-defined domains**



Calculating Storage Efficiency

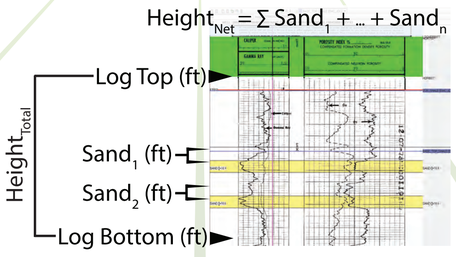
Storage efficiency (E_{Saline}) is a function of the displacement efficiency components and the aquifer characteristics

$$E_{Saline} = E_A \times E_h \times E_\Phi \times E_V \times E_d$$

Defines available pore space | Displacement parameters

- E_A: Ratio of net area to total area suitable for storage resource
- E_H: Ratio of net thickness to total thickness of formations suitable for storage
- E_Φ: Ratio of effective porosity to total porosity
- E_V: Displacement factors
- E_d: Microscopic displacement factors

$$Height_{Net} = \sum Sand_1 + \ldots + Sand_n$$



E_A Area Efficiency

Ratio of net to total area suitable for CO_2 storage

$\frac{Area_{Net}}{Area_{Total}}$ — Area (km²) minus potential leakage pathways / Total area (km)

×

E_h Height Efficiency

Ratio of net to total vertical thickness of formation suitable for storage

$\frac{Height_{Net}}{Height_{Total}}$ — Height (ft) of formation suitable for CO_2 storage / Total height (ft)

×

E_Φ Porosity (Φ) Efficiency

Ratio of effective porosity to total porosity

$\frac{\Phi_{Effective}}{\Phi_{Total}}$ — Portion of the total void space available for storage / Ratio of the entire pore space in a rock to its bulk volume

×

Displacement Parameters

E_V - Displacement factors

E_d - Microscopic displacement factor

E_V & E_d

Calculating the Amount of Storable CO_2

- Storage efficiency is used to calculate the **total storage resource CO_2 (G_{CO_2})**
- Calculation disccused in Goodman et al. (2016)
- This method (Cameron et al. 2018) is built specifically for offshore environment, where density (ρ) is derived as a function of subsea pressure and temperature at a given depth (see diagram to the right)

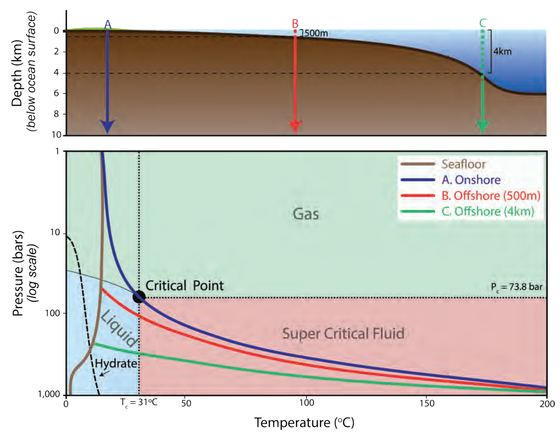
$$G_{CO_2} = A_T \times h_T \times \Phi_T \times \rho \times E_{Saline}$$

A_T: Total area suitable for storage

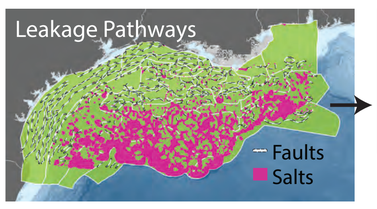
h_T: Gross thickness of suitable formations

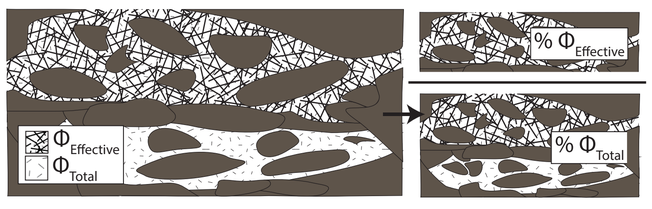
Φ_T: Total porosity

ρ: Density of CO_2 at P, T

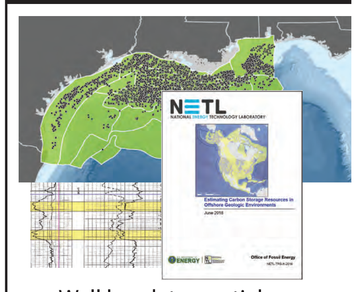


- Logic-based Python scripts were created to estimate storage efficiency (E_{Saline}) and the potential amount of storable CO_2 (G_{CO_2})
- This logic implements Monte Carlo simulations and pseudo-random distribution sampling to known data
- This work compliments the CO2 Storage prospeCtive Resource Estimation Excel aNalysis (CO2-SCREEN) Tool (Sanguinito et al. 2017)

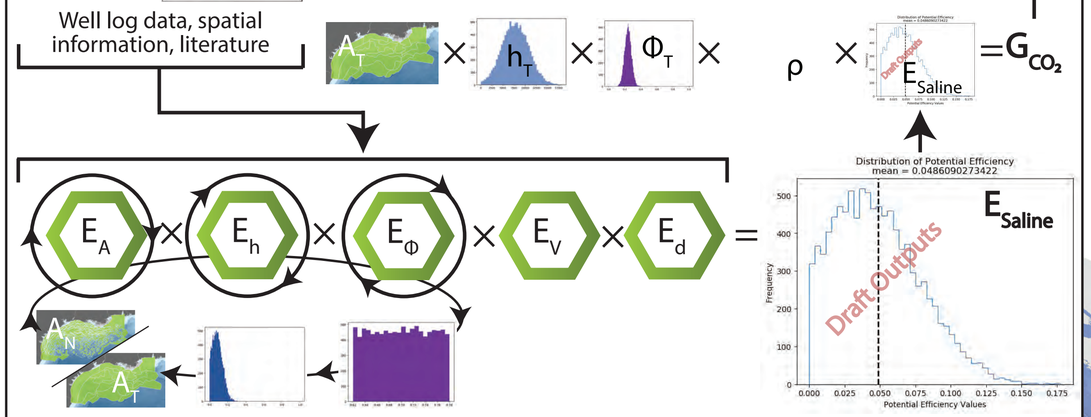




Streamlining Methods with Logic-based Scripts

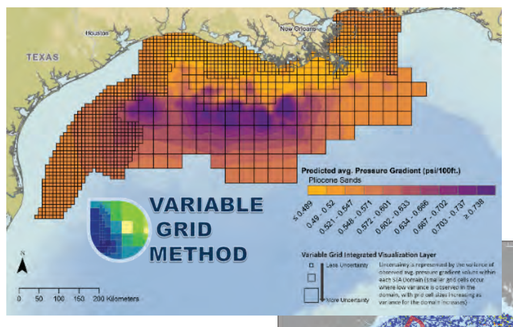


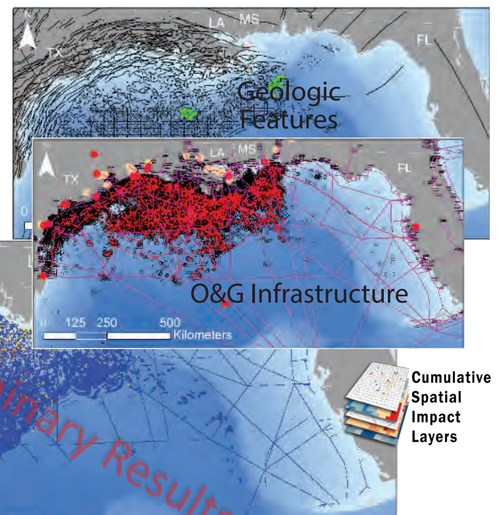
Well log data, spatial information, literature

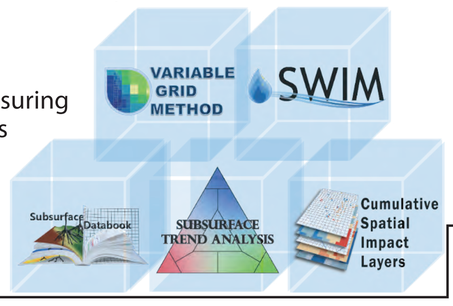


Phase II: Understanding Spatial Risk & Uncertainty

- Phase II leverages NETL's **Offshore Risk Modeling Suite** to characterize risk and uncertainty
- Quantify and communicate uncertainty to create better understanding of the importance of natural seeps and faults
- These tools are capable of measuring P-T adjustments required to assess risk







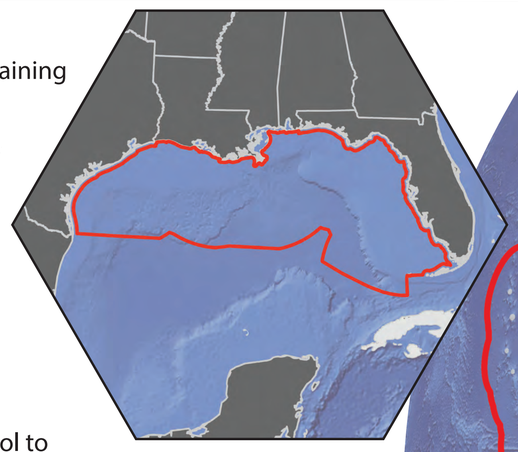
Values Delivered

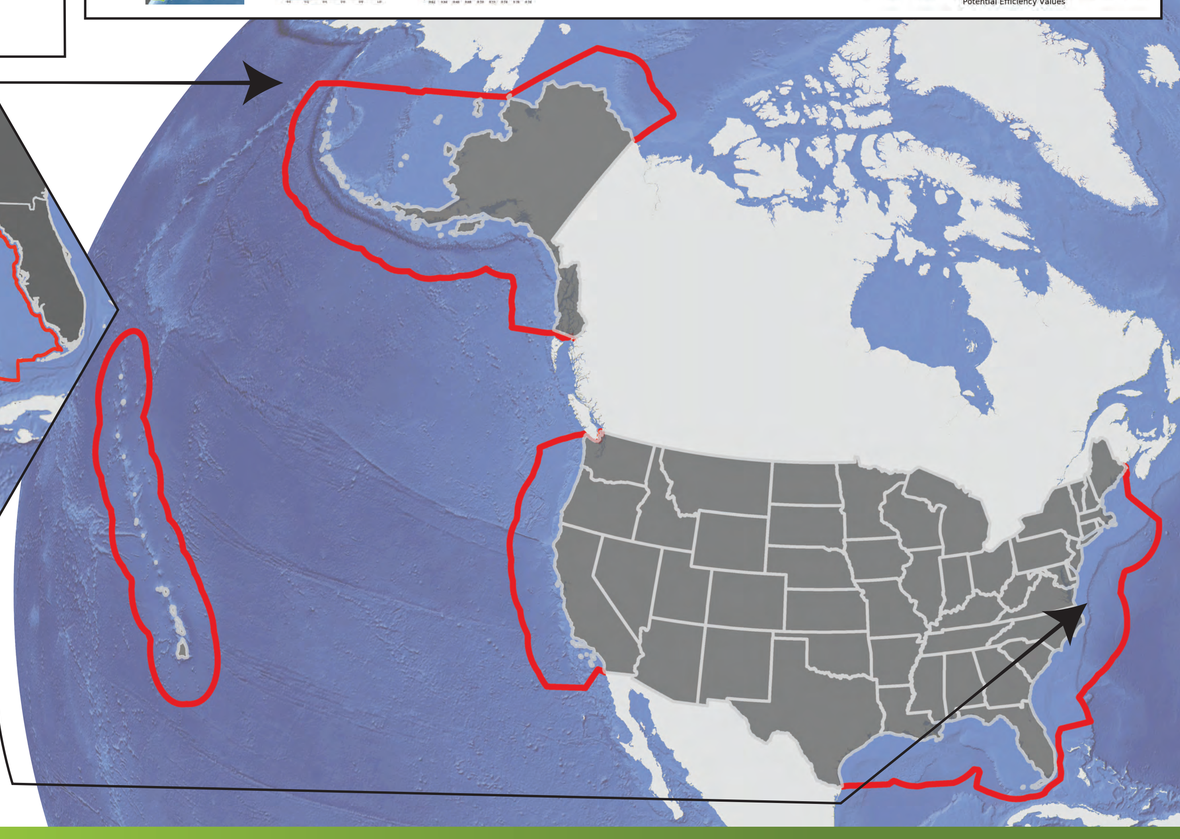
- Improved the accuracy of offshore saline **resource estimations**
- Offshore tailored efficiency terms from DOE carbon storage method
- Data-driven technical assessment of offshore storage resources through integration of NETL's spatial, analytical tools
- Compliments CO2-SCREEN tool, data, models to improve existing stakholder access and utilization

EDX

Next Steps

- Apply methods to remaining U.S. Gulf of Mexico
- Evaluate robustness of offshore efficiency factors in other U.S. waters
- A peer-reviewed publication on the methodology and the associated tool
- Build a user-friendly tool to implement logic scripts
- Release updated versions of tool via EDX





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