SMART tools for Geologic Carbon Storage Applications

Science-informed **M**achine Learning to **A**ccelerate **R**eal **T**ime (SMART) Decisions in Subsurface Applications

Task-6 team (PNNL, LLNL, and NETL)

Presenter (panel discussion):
- **Eusebius Kutsienyo (PNNL)**

U.S. DEPARTMENT OF **ENERGY**

Acknowledgments and disclaimers

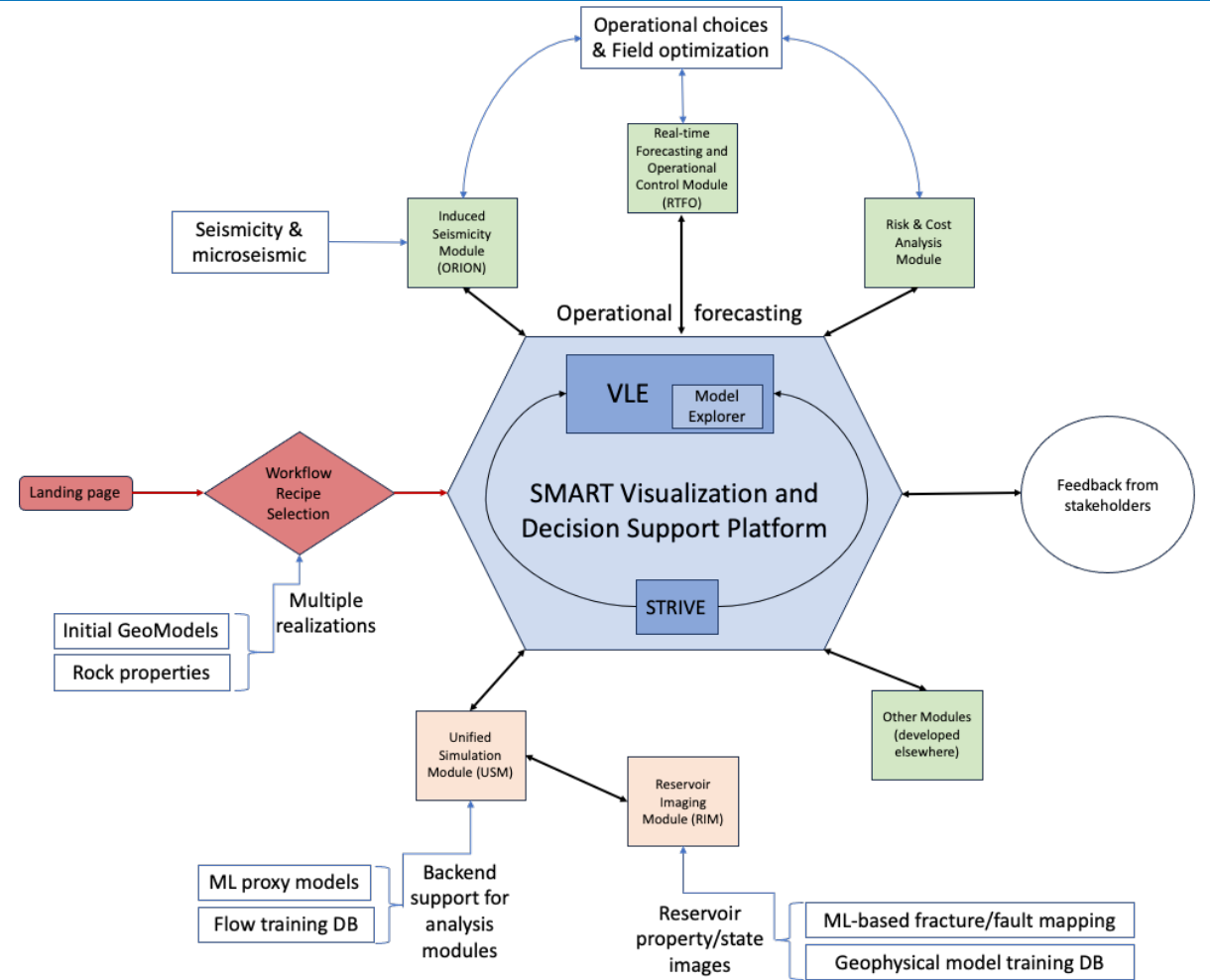# SMART multiverse (end-to-end): Piecing everything together

- Key terminology

  - **SMART Platform**

    - SMART visualization and decision support platform

    - **STRIVE interface** allows to develop consistent look and formatting for SMART modules

  - **SMART Modules**

    - USM, ORION, RTFO,

    - VLE, Model Explorer

    - Risk and Cost Analysis

Version-1 (EY23): Hub-and-spoke figure of SMART platform

Welcome to the SMART Platform
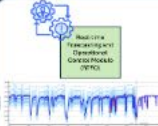

ModelExplorer

Class VI permitting analysis.

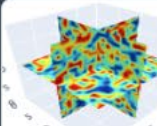Workflow and Tools

ORION

Explore Induced Seismicity factors

Workflow and Tools

RTFO

Forecast and Operation Control.

Workflow and Tools

VLE

Forecasting simulation processes.

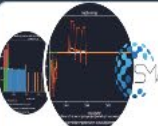Workflow and Tools

RIM

Reservoir Imaging Model

Workflow and Tools

Risk Analysis

Operational risks and costs.

Workflow and Tools

TALES

Economic and Liability Evaluation

Workflow and Tools

Workflow Recipes
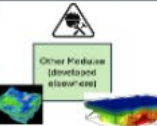
Explore different workflow recipes.

Workflow and Tools

Legacy Code

Predictions from legacy code.

Workflow and Tools

Other Simulators

Numerical and Analytical base GCS developed elsewhere.

Workflow and Tools

Wiring Diagram

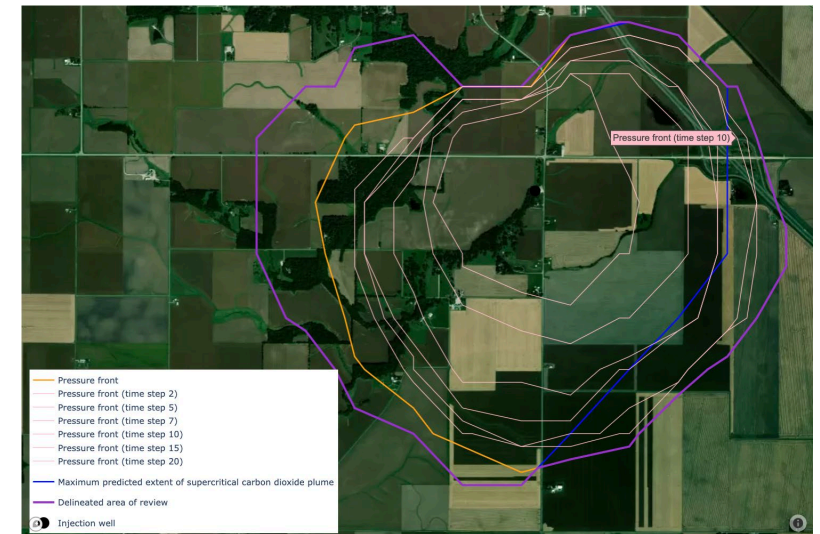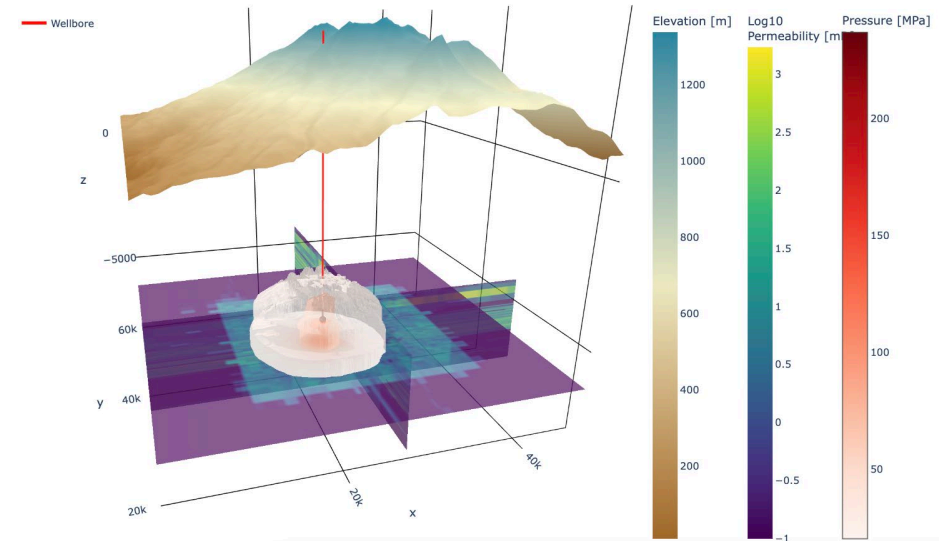Integrated SMART Network

Workflow and Tools

Other Modules

Analytical-based GCS Estimation Developed elsewhere.

Workflow and Tools

Model Explorer Module within the SMART platform

Why is Model Explorer important, and how can it accelerate the Class-VI permitting process?

•Allows for quick visualization of the model inputs, outputs, and other types of data integration, where multiple sets of technical information (e.g., site characterization data and modeling input) can be visualized and evaluated in an integrated fashion.

•Calculates and maps Area of Review (AoR) in real-time in response to model inputs.
  ➢ Displays the evolution and maximum predicted extent of the supercritical CO_2 plume, pressure front, and the combined AoR.

•AoR calculation is based on a pressure-front that can be user defined or determined using the suggested EPA methods.

SMART-Model Explorer

1. Pressure Front ▬▬▬

- User defined threshold.
- EPA Method 1. Under-pressurized injection zone. Pressure front based on bringing injection zone and USDW to equivalent hydraulic heads.

$$P_{i,f} = P_u + \rho_i g \cdot (z_u - z_i)$$

- EPA Method 2. Hydrostatic injection zone. Pressure front based on displacing fluid initially present in the borehole.
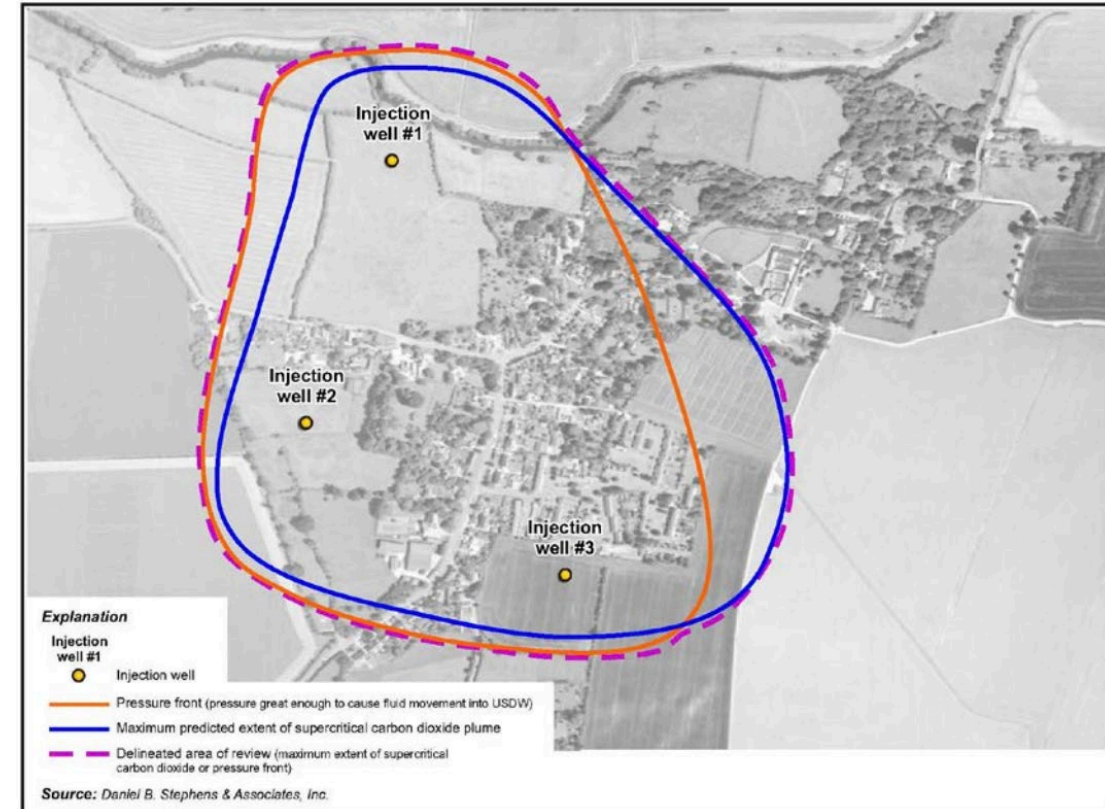
$$\Delta P_c = \frac{1}{2} \cdot g \cdot \xi \cdot (z_u - z_i)^2$$

2. Supercritical CO$_2$ Plume ▬▬▬

- Maximum predicted extent of the separate-phase plume.

3. Area of Review ▬ ▬ ▬

- Combined maximum extent of pressure front and supercritical CO$_2$ plume.

Example area of review contour   epa.gov

SMART Visualization and Decision Support Platform

Task-6 (EY23 and on-going EY24): Key Developers, Contributors, and Participants – PNNL, LLNL, NETL

POCs	Key developers and contributors	Other contributors
• Maruti Mudunuru • Chris Sherman • Hema Siriwardane	• Eusebius Kutsienyo • Patrick Wingo • Alex Hanna • Ashton Kirol • Wenjing Wang • Veronika Vasylkivska • Kolawole Bello • David He • *Mathew Harris* • *Ivani Patel* • *Armando Sanchez*	• Derek Vikara • David Morgan • Diana Bacon • Gavin Liu

SMART

Questions?

Thank you!

Welcome to the SMART Platform

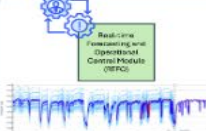## ModelExplorer
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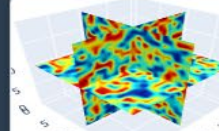Explore Induced Seismicity factors

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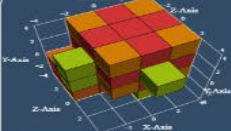## TALES
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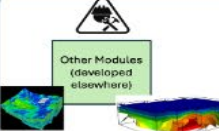Explore different workflow recipes.

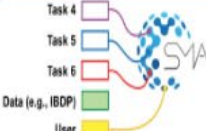Workflow and Tools

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